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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . MANAGING EDITOR

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THE AUXILIARY POLE.

On another page of this issue will be found an interesting article by Mr. H. M. Hobart on the use of auxiliary reversing poles for direct-current, turbine-driven generators. At the high speed of the steam-turbine dynamo, the problem of commutation becomes particularly difficult. For this reason some designers have sought to improve matters by returning to the old auxiliary or commutating pole. Mr. Hobart shows how this pole can be applied to a 750-kilowatt, 250-volt generator driven at 1,500 revolutions. In machines of this size the problem of designing the auxiliary poles and winding the auxiliary coils so as to preserve a perfect balance requires special care. Mr. Hobart deals with the considerations which must be met and gives the complete design of his machine. The steam turbine is making such great progress in central-station operation that the progress in the design of generators to meet its particular requirements is of especial interest.

THE FRANKLIN ANNIVERSARY.

On Wednesday, January 17, the two hundredth anniversary of the birth of Benjamin Franklin was celebrated at many points throughout the country. Franklin will go down as one of the great men of the critical era in the history of this country.

Born of humble parents, and given but a poor education, by assiduous work and careful reading he became recognized as one of the learned men of his time. His talents were not confined to one branch, for he was famous not only as a statesman, but as an author, counselor and a scientific investigator.

A feature of Franklin's scientific work was his devotion to experiment. Although an omniverous reader, he was not satisfied with what others had to say, but sought the truth himself. It is for this reason that his ideas concerning electricity were received with respect. It is somewhat striking that at this time Franklin's single fluid theory, which for years past has been accepted merely as an interesting attempt to explain electrical phenomena by the assumption of an electrical fluid, should now, a century and a half after he proposed it, be again mentioned in connection with the latest physical discoveries. Since we know the electron only through its electrical properties, and since the electrical condition of matter might be explained by the excess or deficiency of electrons, Franklin's theory fits the case. Any such explanation must, of course, be only tentative. It merely signifies that another cycle in scientific research has been completed. Since Franklin's time we have succeeded in dissociating electricity from matter as then known, so we called it a form of energy. Now we find it apparently associated with a new form of matter. But have we done more than carry our knowledge one step further back? We are yet far from knowing whether electricity is a thing or a condition.

GENEROUS GIFTS TO THE INSTITUTE LAND AND BUILDING FUND.

When Mr. Andrew Carnegie so generously offered to give a building to the engineering societies of this country, one condition was that these societies should provide the land upon which the building should be erected. The condition was accepted and to the American Institute of Electrical Engineers fell the task of raising $200,000 for this purpose. A considerable amount has been raised, to which have been added recently two generous donations. One is a gift of $25,000 voted to the fund by the directors of the General Electric Company and the other is the personal check of President C. A. Coffin, of the same company, for $5,000. These two gifts bring the fund up to $100,000, which is one-half the total amount to be raised.

The American Institute of Electrical Engineers has done a great deal to advance the electrical arts and has in this way benefited all those interested in them. It is therefore very

proper that its work should be recognized so liberally. The amounts just presented are not only generously large, but are given unconditionally. If all those who have benefited by the work of the Institute would help along this good work, whether they be members or not, the second half of the fund would soon be raised.

SMOKE ABATEMENT.

A conference on smoke abatement was held in London during December at which some valuable papers were read and discussed on this subject, which is of such importance to that city. These papers contained suggestions of various kinds for abating the trouble, in some cases the suggestions being based on the actual improvement brought about in other cities. While but a few cities in this country are as yet thus plagued with darkness, there are more objections to smoke, using the term in its most general sense, than the cloud-pall produced by unburned carbon. The gases given off may be transparent and contain no appreciable solid matter, yet carry noxious fumes. Sulphur dioxide is a common constituent of fuel gases. Under certain conditions it is oxidized and forms sulphuric acid, which corrodes nearly everything upon which it falls. The air of our large cities, which is generally supposed to be less healthy than that of the country, owes its contamination almost entirely to the products poured out by every chimney, the home being as great an offender as the factory. It is therefore well to follow the work of our British cousins in their attempts to reduce the nuisance.

It seems that the city of Leeds has taken a leading part in fighting smoke. While it does not appear that much effect has been produced overhead, offenders are being watched closely, and Leeds should, ere long, be able to show a decided improvement. There is a society in that city which watches the factory chimneys and reports those which send out an excessive amount of smoke. The law there limits the duration of black smoke from a factory chimney to five minutes in the hour; but the society is asking that the law be altered so as to place the entire control of smoke in the hands of experts. In Berlin the amount of soot thrown out by chimneys has been greatly reduced by the introduction of artificial fuels. In Hamburg a local society employs a staff of experts, the members of which visit factories and other places where much coal is burned, and instruct the firemen in the proper methods of burning fuel. This society has accomplished excellent results.

From some of the papers read at the recent conference it seems that the amount of soot given off by the English chimneys is greater than one would suppose. It is estimated that from the 4,000 tons of coal daily burned in Leeds, twenty tons of soot are deposited. One-quarter of this soot sticks, so that every day five tons of lamp-black are painted over the city of Leeds. What the daily covering of London amounts to is not stated in any of the papers.

Among the suggestions for eliminating the smoke-cloud was, of course, that of supplying the cities with gas for fuel instead of coal. This would avoid carrying the solid residue, ashes, to the cities, and as there is less difficulty in securing complete combustion of gas than coal, there should be but little soot produced. Unfortunately, the transmission of gas over long distances is not very efficient, commercially speaking, and there still remain the objectionable fumes produced by its combustion. These fumes may not only be actively objectionable, as, for example, when acids are produced and when, through incomplete combustion, carbon monoxide is released, but the wholesale pouring out of carbon dioxide gas, harmless in itself, serves to impoverish the air and is for this reason undesirable.

The ideal method of supplying the needs of a city is to erect large electric generating stations at the mines. At this point the production of soot would not matter much; besides, a large station, such as contemplated, would be furnished with the most highly developed furnaces, and would probably give off little smoke. Nor would the pouring out of large amounts of chimney gases be objectionable if not done in the vicinity of a town. In this way the city would be supplied with its energy and the objectionable residues of the fuel, both solid and gaseous, would be left at the mine. Unfortunately, we are not yet far enough advanced to carry out this plan. For various reasons, electrical transmission from mine to city can to-day compete with the generation of power in the city in but a few instances, and therefore the latter system will persist until it is forbidden by law or until advances in the electrical art put it ahead of the former. This is particularly true as regards heating, for under the best conditions we are to-day not able to develop in our electric heaters more than ten per cent of the heat of the fuel. When it becomes possible to deliver, say, fifty per cent of our fuel energy as electrical energy, the smoke problem will be solved. We to-day seem far from this happy stage, as our present methods of generating power from coal promise but slight improvement. The many attempts to develop a system of direct conversion of fuel energy into electrical energy have been failures. It would seem from what we know of the methods that have so far been tried that they offer little hope for a successful solution, but this does not mean that the problem is insolvable. The end sought is well worth the efforts of many investigators, and to the fortunate one who may succeed will come fame, fortune and the gratitude of mankind.

A SUGGESTION FOR A SMOKE HELMET.

Not infrequently firemen are baffled in their work of extinguishing fires or of rescuing lives by the choking smoke and gases which fill the building. To meet such emergencies, smoke helmets have been provided which the fireman wears, and to which is connected an air-pipe supplying him with breatheable air by means of a pump placed outside the building. Devices of this kind have been adopted widely in Europe where they, no doubt, have performed good service. Frequently they are connected with a telephone, which adds nothing to the encumbrance of the fireman, since he must already drag along with him his air-pipe. Unfortunately, this pipe must prove a serious inconvenience at times, if not a danger, as it not only hinders the man in his work, but there is a possibility of its becoming

caught and thus causing his death. The difficulty would be overcome if the pipe could be done away with; in fact, this has been done in an apparatus which carries along a store of oxygen compressed in a suitable tank. Such a device must also have its inconveniences, which suggests the idea that it might be replaced by an oxygen generator charged with some one of the newer electrically prepared reagents, which, upon contact with water, set free oxygen. With a small generator attached to his back, a little supply of water and a proper regulating valve, the fireman would have at his disposal a supply of oxygen which would last him for a long time. It would not be hard to control the rate at which the gas is set free and delivered to the helmet. The cost of the supply would be trifling compared with the work which might be done. It is probable that by the use of a device of this nature many lives might be saved each year and fires which would become destructive extinguished at the start.

TRESPASS BY TELEPHONE.

A device which has grown so rapidly in popular favor, and which is used so constantly as the telephone, might be expected to bring with it some disadvantages. In the case of the telephone these inconveniences fortunately have been of a minor character. They are, however, annoying, particularly as they are inflicted directly upon the busy man. One of these troubles was brought to notice recently by a case in a Massachusetts court. The complainant stated that he was continuously annoyed and deprived of rest and sleep by frequent telephone calls, the caller having no other object in mind than to annoy the called. The court said that in this particular case it could not intervene, as the two parties concerned were husband and wife, and the former had taken certain chances when he married, the consequences of which he must now bear. However, the court held that, in general, a person who annoyed another in this way might be enjoined from trespassing. This case has excited some interest in the daily press. The New York *Times* comments upon it in the following words:

Every one of us who works within hearing distance of a telephone knows perfectly well that trespass can be committed over it from the other ends of innumerable wires and by anybody inclined to that particular form of crime. For some mysterious reason, probably connected with the fact that the telephone is still something of a wonder to, and therefore highly respected by, us all, there is a certain compulsion about every "call" and they are almost invariably "answered," at whatever loss of time or convenience. Thus do people easily get into communication with those whom they could otherwise approach only with difficulty or not at all. There really ought to be some sort of responsibility imposed upon "callers"—an obligation to justify their procedure in some such way as all other personal contacts of an analogous kind must be justified—that is, by friendship, acquaintance, or the existence of such legitimate business as would warrant a like demand upon the attention of the person called. Of course, no hard and fast line could be drawn between propriety and trespass, but the present utter lawlessness in the matter is already highly unsatisfactory and is steadily getting more so as the number of telephones increase. The right of privacy is worth protecting.

The annoyance, of course, is admitted by all, but there should be little difficulty in bringing it under control, if not abolishing it altogether. When any one calls at a busy office he must state his business, if he is not known or brings no introduction, otherwise he can not gain admittance to the sanctuary. To-day practically all large business offices have a private telephone exchange, under the control of a clerk; probably the same clerk who interviews all callers. Why, therefore, should it be improper for him to interview the telephone caller and turn aside those whom he would not admit in person? One who calls up an office by telephone has a certain advantage, since there is nothing to judge his intentions by except his voice. He should therefore not feel injured at all if the office called questions him regarding his desires. If it is proper for a busy man to refuse to see a caller because he is busy, why should not the same excuse be just as good for refusing to talk over the telephone? The popular idea of a telephone conversation is a brief exchange of words, to the point, but this, unfortunately, is not always the case and it may be dragged out by an insistent talker unless the man at the other end takes things in his own hands. Fortunately, he is able to close the conversation at any time that he sees fit, and he can generally manage to do this without being unnecessarily rude to those callers who succeed in getting by the telephone clerk. The blame for the annoyance must, of course, be laid to the person who calls, but the cure for it can be found at the office called.

CITY NOISES.

The daily papers of New York have taken up vigorously the cause of those residents along the water-front who object to the unremitting whistling of harbor craft, and the united efforts of all promise to reduce greatly this nuisance.

This form of annoyance is not the only one to which city residents are exposed. Our present elevated railroad structures are practically sounding-boards to multiply the noise of the passing train. Berlin has attacked this problem, Boston has taken up the question, as has also Chicago. It may be that with the present structures but little improvement can be made, but the matter should be borne in mind in all new structures of this kind. This applies not only to long roads, but even to short viaducts, when they pass near residences.

Street traffic also gives rise to unnecessary noise. Sometimes the type of pavement is to blame, but not infrequently the sound is due to the character of the load. If we can suppress the shouting of street peddlers, why can't we require truckmen and others to have some consideration for our nerves?

The large city is not the only place where the would-be sleeper is made to suffer. Country trolley lines are sometimes equipped with horrible bells or with ear-splitting whistles. Steam locomotives seem to enjoy whistling whenever there is any excuse. We are aware of one important suburban road serving a large city which has stopped the use of the whistle for all purposes except warnings at crossings; in fact, to-day there seems to be little need for the whistle when approaching a station.

These are only a few of the annoyances to which we are subjected, both in the city and country, and it is about time that we gave more thought to these little matters; and we may be sure that there will be no abatement of a nuisance unless there is a demand for action.

THE ELECTRICAL NATURE OF MATTER AND RADIOACTIVITY.

BY HARRY C. JONES.

CHAPTER XVI.—(*Concluded.*)

About this time a suggestion was made by Joly, which is well worthy of serious consideration. Joly suggested that instead of radium being a disintegration product of uranium or thorium, it may be produced "as an atomic combination of radioactive products with some of the elements present in pitchblende. The radium would represent the synthesis of an element, not its decomposition. On this view some of the radioactive products of uranium (or thorium) can, in virtue of their great kinetic energy, enter into the atoms of intermixed substances, such as barium, bismuth, etc., giving rise to the new atom, radium. If this hypothesis is correct, we should seek to observe the genesis of radium not in any one of the radioactive elements, but in molecular intermixtures of these with the various bodies we know to be conspicuously present in pitchblende, seeking among the various combinations for a positive result."

This suggestion of Joly is especially important if it should be shown that the atomic weight of radium is greater than that of thorium or uranium. We would naturally expect these substances in breaking down, to yield products with smaller atomic weights than their own. If radium has a larger atomic weight than either of these radioactive elements, it is a little difficult to see just how it could be formed as the direct result of their disintegration. It might, however, be produced by the recombination of certain of the decomposition products of these elements with one another, or, as Joly suggests, by the combination of these with other substances occurring in the pitchblende.

Some light has been thrown by McCoy on the possible origin of radium. He pointed out that if radium is a decomposition product of uranium, all uranium minerals must contain radium, and in quantities proportional to the amounts of uranium in the minerals. Since all intermediate products, such as uranium X, the radium emanation, etc., are present in these minerals in quantities proportional to the total amounts of uranium, it follows that the total radioactivity of every natural uranium ore is proportional to the amount of uranium contained in it.

McCoy analyzed a number of uranium ores from different localities, and determined their radioactivities by means of the electrical method. He found that the activity of all uranium ores, which did not contain appreciable quantities of thorium, was directely proportional to the amount of uranium contained in them. In other words, the radioactivity of any given quantity of any uranium ore, divided by the percentage of uranium contained in it, is a constant. This constant was termed the activity coefficient.

It was further shown that the radioactivity of chemically prepared uranium compounds is directly proportional to the amount of uranium contained in them. Such compounds also have a constant activity coefficient.

More elaborate experiments on this same problem have been made by Boltwood, who arrived, however, at essentially the same result. The amount of radium contained in the uranium minerals was determined by measuring electrically the emanation that is given off when a weighed quantity of the mineral is dissolved or decomposed, and the solution boiled or allowed to stand in connection with a closed glass vessel. We can measure the activity of the emanation very accurately, and this furnishes us with an accurate means of measuring the amount of radium in a given substance. If we simply wish to determine the relative amounts of radium in any two substances, it is only necessary to measure the activity of the emanation produced by equal weights of these substances.

Boltwood used an improved method for analyzing the uranium minerals, which is obviously very important. The results which he obtained for somewhat more than twenty uranium minerals are very satisfactory, pointing conclusively to the proportionality between the amount of radium in the mineral and the amount of uranium present.

To give a more exact idea as to the meaning of this relation, Boltwood divided the amount of radium in the mineral by the amount of uranium, to see whether the ratio would be constant for the different minerals. The author concludes that from the data "it is evident that a direct proportionality exists between the quantities of radium and the quantities of uranium, and the inevitable and only possible conclusion is that uranium is the parent of radium."

He points out that certain of the methods that have been used for determining uranium are defective, which is obviously a matter of the greatest importance in the present connection.

Boltwood has carried out experiments similar to those of Soddy to see whether radium is produced directly from uranium. He comes to the same conclusion as Soddy—that it is not. He agrees with the suggestion of Rutherford that probably one or more intermediate products exist between the uranium atom and the radium atom. Such products, however, have not yet been discovered, unless the suggestion of Rutherford that possibly actinium is such a product, is correct.

In a quite recent paper, Rutherford and Soddy point out that as the amount of radium in uranium minerals is proportional to the amount of uranium present in those minerals, the amount of radium per gram in the mineral should, of course, be a constant. The value of this constant can easily be deduced if the relative activity of pure uranium and pure radium is known. To determine the amount of radium occurring with say one gram of uranium, they compared the radioactivity of the emanation from the standard amount of pure radium bromide with that from the mineral containing a known quantity of uranium.

They found that *"the quantity of radium associated with one gram of uranium in a radioactive mineral is equal to approximately* 7.4×10^{-7} *gram.* One part of radium, therefore, occurs with about 1,350,000 parts of uranium.

From these data it is easy to calculate the amount of radium occurring in uranium ores. They find that in a ton of pitchblende containing sixty per cent of uranium, which is a rich uranium ore, there is 0.4 of a gram of radium. Lower grades of pitchblende, which contain less uranium, will contain proportionally less radium.

Boltwood also took up the earlier work of Soddy, in which the latter came to the conclusion that radium is not formed from uranium, because uranium nitrate which had stood for a year or so did not contain any appreciable quantity of radium.

He repeated the experiment of Soddy and obtained similar results. A quantity of uranium nitrate was carefully purified by recrystallization, and 100 grams were dissolved and the solution sealed up in a bulb. After standing thirty days the bulb was opened and all gases removed from the solution by boiling. All of the gases removed from the solution were transferred to an electroscope. It was found that the amount of radium present in the uranium at the start was less than 1.7×10^{-11} grams. The uranium solution was again sealed up in the bulb and allowed to remain for six months. The

amount of radium present was again tested and found to be less than 1.7×10^{-11} grams.

After 390 days the test was repeated, and with the same result, the amount of radium present in the solution still being less than 1.7×10^{-11} grams. If any radium was formed from the uranium during this period, the above results show that *less than one sixteenth-hundredth* of the quantity required by the rate at which radium decomposes to establish and maintain the equilibrium, was formed.

These results would seem to show pretty conclusively that *radium is not formed directly from uranium.* The work of McCoy and Boltwood, however, establish a proportionality between the amount of radium in uranium ores, and the amount of uranium contained in them. Taking all these facts into account, we must conclude that uranium is the parent of radium, but that the latter is not produced directly from the former. One or more intermediate products with a slow rate of change must be formed. These on breaking down yield radium directly or indirectly.

It will be remembered that Rutherford suggests that actinium may be such a product. Whether this is the case, and what is the nature of such intermediate products, can be determined, if at all, only after a much larger amount of work has been done on this problem.

CHAPTER XVII.

Theoretical Considerations.

Importance of a Theory or Generalization.

The chief aim of scientific investigation is not the discovery of isolated facts. Indeed, we might continue to unearth such facts for an indefinite time, in any branch of natural science, and it is a question whether such knowledge ought to be dignified with the name of science.

The highest aim of scientific investigation is the discovery of theory or generalization, which, when sufficiently established, becomes a *law.* This may or may not be an ultimate truth, probably is not, but may be as near to it as the methods at present at our disposal are capable of leading.

It can be asked how do we arrive at generalizations in science? The answer is, for the most part by the inductive method. We discover fact after fact and then coördinate and correlate these individual facts, and the result is a generalization.

It may then be said, and fairly, that the discovery of facts are highly important, indeed, essential to the discovery of generalization or law. From this no man of science will dissent. The discovery of isolated facts bears the same relation to science as the making of bricks to architecture. The bricks are absolutely essential in constructing the building, but *they are not the end or aim* of the architect. They are simply a means toward the end, which is utility or beauty, or both. Just so in the investigation of natural phenomena; we must study the isolated facts; they are the bricks or individual units of which science is made. They are, however, not science, and not the end of scientific investigation. They are but the means to the end. The generalization in science may be compared with the finished edifice in architecture.

We have now studied a large number of facts pertaining to radioactivity. Some of these are of a striking nature, and arouse deep interest when considered by themselves. Their real importance and significance, however, comes out when we consider them in *their relations to other facts,* and especially to well-established generalizations, which we now accept as the philosophy of the physical sciences.

We shall next attempt to coördinate the facts of radioactivity, now well in mind, and see what generalizations have been reached. We shall learn that new light has been thrown on the nature of what we call in chemistry the atom, and on the genesis of matter by the study of various phenomena connected with radioactivity.

The More Important Facts in Connection with Uranium.

Before taking up the generalizations that have been reached, a brief summary of the facts in connection with the several radioactive elements will be given, by way of review, since it is these facts that have to be dealt with primarily by any theories that have been proposed.

The element uranium gives off α, β and γ rays. The *alpha rays* are composed of material particles, having a mass from two to four times the mass of the hydrogen atom. These particles are shot off at very high velocities, and therefore have considerable momentum. The alpha particles are charged, and are, therefore, deflected in the magnetic field. The direction of their deflection shows that they are charged positively. Every α particle carries a unit electrical charge, as we say; that is, the amount of electricity carried by a univalent ion in solution.

The alpha particles produce strong ionization of the gas through which they pass; indeed, most of the ionization effected by radioactive substances is due to the alpha particles.

The alpha particles have marked power to produce fluorescence in certain substances, especially zinc sulphide and barium platino-cyanide. The phenomena manifested in the spinthariscope are due, for the most part at least, to the alpha particles.

The alpha rays produce but little effect upon a photographic plate, and, therefore, the photographic method can not be used to measure the intensity of this kind of radiation.

The alpha particles being material in nature are easily cut off by matter. They can not pass through even very thin metallic screens.

The beta rays are closely analogous to the cathode rays. The mass of the beta particle is about 1/770 of the mass of the hydrogen ion. These particles are shot off with different velocities, but all with very high velocities, indeed, of the order of magnitude of light. The mass being small, the momentum of the β particle is much less than that of the α particle, notwithstanding the fact that the β particle moves with greater velocity.

The β particles are deflected by the magnetic field, indeed, much more strongly than the α particles. They are, however, deflected in the opposite direction to the α particles, and therefore have a negative charge. Every β particle carries a unit negative charge of electricity.

The β particles produce comparatively little ionization in the gas through which they pass.

The β particles have comparatively little power to excite fluorescence in fluorescing substances. The β particles have greater effect upon a photographic plate than the α particles. They are cut off by metallic screens of any considerable thickness, but have much greater penetrating power than the alpha rays.

The *gamma rays* are analogous to the X-rays. These rays are shot off *as pulses,* with very high velocities. The γ rays are not deflected at all by the magnetic field. They produce comparatively little ionization in gas, and have but little power to excite fluorescence. Like the β rays, they have marked action on a photographic plate. They have great penetrating power; not only many times greater power to penetrate matter than the β rays, but even greater penetrating power than the X-rays themselves. As has already been pointed out, Rutherford has been able to detect the γ rays after they

have passed through a foot of solid steel. Gamma rays are produced by the β rays, and are never present without them.

Uranium is continually, but very slowly, undergoing a transformation, giving rise to a form of matter that differs in properties from the uranium itself. This new form of matter is called uranium X. The rate at which uranium X is formed is independent of all physical and chemical conditions. In the formation of uranium X from uranium, α particles are given off.

Uranium X, in turn, undergoes decomposition, giving off β and γ rays during the process. The rate of the decomposition is also independent of all conditions.

(To be continued.)

BOOK REVIEWS.

"Mechanical Engineering." Charles M. Sames. Jersey City, N. J. Published by the author. Leather. 168 pages. 4⅛ by 6¾ inches. 31 illustrations. Supplied by the ELECTRICAL REVIEW at $1.50.

The author of this book states in his preface that he has endeavored to present the facts most used by engineers in order to obtain a volume which may be carried in the pocket. The book contains nine chapters dealing with mathematics, chemical data, materials, the strength of materials, structures, machine parts, power and transmission, the steam engine, hydraulics, shop data and electrotechnics. These are all very concisely treated, in fact almost too briefly. The matter contained in the book is similar to that in the standard engineer's pocketbooks and it follows their style closely.

"Modern Locomotive Engineering, with Questions and Answers." Calvin F. Swingle. Chicago. Frederick J. Drake & Company. Flexible leather. 630 pages. 5 by 7 inches. 265 illustrations. Supplied by the ELECTRICAL REVIEW at $3.

This book was written with the aim of instructing young men engaged in locomotive engineering. It first gives concisely the duties of fireman and engineer and presents in these chapters some elementary instructions on heat, combustion, steam, etc. The following chapters take up the construction of various portions of the locomotive: the boiler and its accessories, the throttle valve, dry pipe, valves, valve gears, piston valves and balanced valves, etc. Other chapters deal with valve settings, compound locomotives, the indicator and its use, the accessories of the engine, including injectors, steam gauges, safety valves, etc. Another deals with the possible accidents which may happen to the locomotive on the road, and in it are given the proper proceedings to follow in case of any of these accidents. The last one hundred pages of the book are devoted to the air brake, the Westinghouse and New York systems being described. A particularly valuable feature of the book for the students of the locomotive is the questions following each chapter. The answers to these questions can be found only by close study of the chapter to which they are attached. The reader who carefully goes over the questions and answers will have a good working knowledge of all the parts of the machine by the time he has finished the book. The book is incomplete in some respects. In the chapter on valves and valve gears the only system described is the Stephenson link. None of the later systems which are being adopted by the American railroads is even mentioned. On the whole, however, the book is a good one and should be in the hands of all locomotive engineers and firemen.

"Modern Turbine Practice and Water Power Plants." John Wolf Thurso. New York. D. Van Nostrand Company. Cloth. 244 pages. 6½ by 9½ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $4.

Mr. John Wolf Thurso has divided his book into two parts: part i having seven chapters and part ii two chapters and an appendix, the former covering modern turbine practice contains in chapter i turbine practice in Europe; turbine development in Europe; present turbine practice in Europe; turbine pumps; chapter ii, turbine practice in America; turbine development in America; present turbine practice in America; the turbine as a hydraulic motor; the turbine as a machine; causes of lack of progress among American turbine builders. It will be seen at the start from the contents of these first two chapters that this book treats the subject not only from an American standpoint but internationally, which practice can not be overestimated. Under chapter iii are classified the turbines as the reaction turbine, the action turbine and the limit turbine, while under chapter iv the various types of steam turbines and their construction is treated in sixteen pages, accompanied by excellent cuts representing sections of the Parsons turbine, runner and nozzles of the De Laval turbine and also a plan of this type of turbine. A diagram showing the steam travel in a Curtis turbine is also given. This chapter, the author states in his preface, was included "on account of the growing importance of the steam turbine and its close relation to the hydraulic turbine." Inasmuch as the steam turbine is of such great interest and importance to the hydraulic engineer, the descriptions covered in these few pages might very profitably have had more space devoted to it, if it should appear at all in a book of this character. In this same fifth chapter are also covered turbine construction in general, turbines for high, medium and low heads and their manufacture. This section is profusely illustrated with many excellent cuts showing the various types of the different manufacturers, including both European and American practice. A well read hydraulic power-plant engineer will find many illustrations with which he is familiar, although too little attention is paid to the later hydraulic plants at Niagara Falls, the most prominent existing to-day. Chapter vi covers the accessories of turbines, such as draft tubes, stop valves, throttling gates, for speed regulation and gauges, while chapter vii treats governors and speed regulation. Probably of greater interest to a power-plant designer is the second part, chapters viii and ix, covering water-power plants. Here are given valuable suggestions for the design of water conductors, head and tail-races, water-racks, head-gates and penstocks. Under chapter ix the development of water power is treated, under which head are also discussed typical features of American water-power supply, including anchor and frazil ice, measuring of water for setting water power and the cost of water power. Here the author's work ends with an abridged table of British and metric measures and values, which is invaluable on account of the daily increase in the use of the metric system. The appendix consists of a reprint of a paper presented at the sixteenth general meeting of the American Institute of Electrical Engineers, at Boston, 1899, by Allan V. Garratt. It is a valuable paper and contains many good formulæ. The need of a good hydraulic power-plant book has been felt for many years both here as well as in Europe, and it is remarkable to note that simultaneously with Mr. Thurso's book a similar work was published for the German-speaking countries. Looking on the author's work, as a whole, it can be stated that it is an excellent and welcome volume both for manufacturers and designers of hydraulic plants, and as hard as it is to lay down fixed rules for the design of hydraulic plants, Mr. Thurso has covered the field thoroughly.

A New Form of Lamp Bulb.

A new form of incandescent lamp bulb has been devised by Mr. E. Böhm. The type is known as the "lens" lamp, and was exhibited recently in London. The feature of this lamp is the shape given to the walls of the bulb, which are formed into a series of lenticular rings designed so as to give any desired distribution of light. Tests made of samples of this lamp showed that the vertical intensity of the light was increased about five times, the horizontal intensity decreasing somewhat. It is said that the price of this lamp is considerably higher than that of the ordinary type.

A Review of Wireless Telegraphy—II.

By William Maver, Jr.

ANOTHER autodetector is that known as the Lodge-Muirhead oil-film autodetector. This detector is apparently a modification of the Castelli mercury detector. It consists of a rotating steel disc, the lower edge of which enters a vessel containing mercury, but the disc is normally prevented from making contact with the mercury by a film of oil on the surface of the mercury. Electric oscillations in the detector circuit cause the mercury and disc to cohere, setting up variations of current in the shunt circuit that affect a siphon recorder which gives a record of the arriving signals in dots and dashes on a paper strip. A telephone receiver may be used in place of the recorder.

Another type of detector that is in practical operation is the Branly needle coherer. This consists of a tripod formed of steel needles, the points of which rest lightly on a polished metal surface. The needles themselves are oxidized or rusted. This is said to make a sensitive coherer, but it is not automatic in its action, requiring a tapper to bring about decoherence.

The two most prominent workers in the field of wireless telegraphy in this country —De Forest and Fessenden—starting out on widely different lines, have seemingly arrived at a common point in the construction of an autodetector. De Forest first employed in his wireless work an electrolytic detector, which he termed an anticoherer, constructed on the fact that certain electrolytes separating two metal electrodes become better conductors when a direct current is set up in the circuit of which they form a part. The electrolyte, in this instance glycerine and water with some oxide of lead as a depolarizer, is contained in a small glass or ebonite tube. When tin electrodes are used the current tears from the positive electrode small particles of the metal, which form a bridge or pontoons between the two electrodes, reducing the resistance of the circuit. Arriving electric waves set up electric oscillations in the circuit which disrupt the bridge, whereupon the resistance of the circuit increases and variations of current are effected in a local circuit, producing signals in the telephone receiver employed for the purpose.

The detector more recently used by De Forest consists of a platinum wire in a solution of nitric acid, which is found to be sensitive and reliable. According to De Forest the action of this detector is electrolytic, a small battery in the circuit setting up a counter-electromotive force of polarization, which has the effect of increasing the apparent resistance of the circuit. Incoming oscillations cause a temporary reduction of the counter-electromotive force, thereby effecting an increase in the conductivity of the detector circuit, with the usual result of producing sounds in the telephone receiver. De Forest has termed this an electrolytic receiver.

Fessenden, on the other hand, first devised what he termed a hot-wire barretter, consisting of a very fine short loop of platinum wire enclosed in a glass bulb to prevent radiation of heat. He found that electric oscillations varied the current in the detector circuit by varying the temperature of the fine wire. For this reason

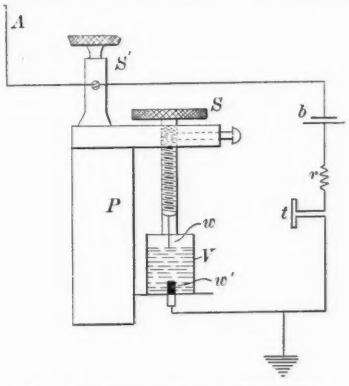


FIG. 3.—ELECTROLYTIC DETECTOR.

the device has been termed a thermic detector. From this was evolved the device which consists of a very fine platinum wire dipping into an acid solution contained in a small vessel. Fessenden claims that the action of this detector is due to the fact that the resistance of a cylindrical body, such as a wire, in a conducting medium, is practically all localized and concentrated within a short distance of the point where the wire enters the conducting medium, namely, in this case, the acid solution. Hence, the heat effects of the circuit are concentrated about this point. Electric oscillations in the circuit temporarily dissipate this resistance, causing variations in the current strength which are perceived in the telephone receiver as sounds. Fessenden has termed this detector a liquid barretter.

The general appearance of this detector is indicated in Fig. 3. The vessel V contains the electrolyte, sometimes nitric acid, sometimes an alkaline solution; w is the fine wire, the extent of the entrance of which into the liquid is regulated by the screw S; w' is the lower electrode, the size of which is not material; t is a telephone receiver, b is a small battery of dry cells; r is a resistance or potentiometer, to regulate the strength of current necessary for polarization or heating, as the case may be. P is the supporting part of the detector.

The discovery of this detector has also been attributed to Ferrie, Pupin and Schloemilch. The latter has transferred his claims to the Telefunken Wireless Company, by whom it is now being utilized in practice. According to Schloemilch, when an ordinary polarized cell (for instance, platinum or gold electrodes in an acid solution) is connected to an electromotive force somewhat higher than the electromotive force of decomposition, so as to have a slight evolution of gas on the electrodes, due to the permanent decomposition current, an ammeter in the circuit will show an increase of current on the occurrence of electric oscillations in the curcuit. Schloemilch does not attempt an explanation of the action of the cell, and considers it still an open question whether the cell represents an ohmic resistance or a capacity, but gives the preference to the former view.

De Forest and Schloemilch have found that this detector may be used with a relay. In practice, however, De Forest employed it with a telephone receiver. It was this detector which was employed in the wireless telegraph operations in the Far East by the De Forest company in the transmission of war news. Schloemilch has found that by choosing two electrodes in the cell having as wide a difference as possible in the series of electrical pressures the battery may be dispensed with. Shoemaker in this country uses a detector employing the last-mentioned principle.

One of the advantages of this autodetector is its property of responding to electric oscillations proportionately to their intensities, and it rarely ceases to work abruptly, as do certain other types of detectors. Another advantage is the ease with which it may be regulated by varying the electromotive force of the battery. It also possesses the important advantage when used on shipboard of not being sensitive to shocks or jars. It is,

however, liable to be burnt out by heavy currents in its circuit. It is understood that De Forest has dispensed with the fine-wire electrode in this cell, substituting therefor a larger electrode, obtaining therewith satisfactory results and at the same time avoiding some of the disadvantages of the wire of microscopical diameter.

The diameter of the fine platinum or gold electrode used by De Forest and Schloemilch is given as about thirty-eight one-millionths of an inch. Fessenden's fine wire is stated to be four one-hundred-thousandths of an inch in diameter. Possibly this extreme fineness of wire may not be absolutely necessary, since experiments with platinum electrodes more than one-thousandth of an inch immersed in a solution of nitric acid have given satisfactory results at a distance exceeding two hundred miles. It is obvious that wires of the smaller sizes stated must be more or less difficult to handle, being liable also to turn up and float on the liquid. To avoid this defect the fine wire is sometimes covered with a glass cone, from which the wire protrudes a small fraction of an inch. By this device a constant amount of wire surface is always exposed in the liquid regardless, for instance, of the rolling of a ship.

The practicability and reliability of this type of detector, or modifications of it, appear to be demonstrated by its adoption by so many inventors and workers in wireless telegraphy. In this relation it may be noted that by a recent decision of a New York court it is held that the Fessenden patent claim covering "an electrical receiver consisting of a liquid and an extremely fine terminal projecting into the liquid" is valid, the manner of operation of the device not entering into the question.

It is not, however, at all likely that the end has been reached in the matter of electric-wave detectors, or for that matter in any of the other apparatus and methods used in wireless telegraphy. No doubt the near future will see many notable improvements and simplifications in every branch of the art.

Various forms of the Rhumkorff coil, giving a six or ten-inch spark, are still employed in numerous instances in wireless telegraphy as a means of developing the electric oscillations in the transmitting circuit. The electric power used in the operation of these coils is about seventy-five or eighty watts (ten volts and eight amperes). The difficulty of keeping the ordinary vibrator or interrupter of such coils in adjustment and the proneness of their contact points to wear quickly under the heavy currents employed, are objectionable features, to avoid which separate interrupters of the mercury turbine type are frequently employed. To still further avoid the use of interrupters and in order also to meet the demand for greater radiating power in long-distance wireless transmission special forms of open or straight-core transformers are now utilized. The capacity of these transformers ranges from one kilowatt to twenty-five

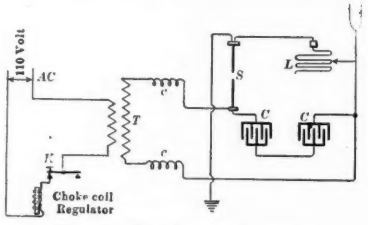


FIG. 4.—DE FOREST SYSTEM.

and thirty kilowatts. The electromotive force of the primary circuit is developed by an alternating-current generator at about 110 volts and sixty cycles, which is stepped up by the transformer to 25,000 volts in the oscillating circuit. These generators are driven by oil or gas engines or by electric motors. The motor generator usually takes current from the regular street service or from the ship's dynamo. In Fig. 4, which theoretically represents the De Forest transmitting apparatus and circuits, T is an open core transformer in which the core is made up of a large num-

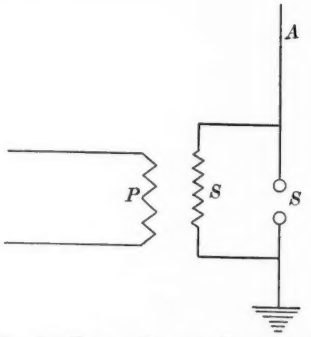


FIG. 5.—AN EARLY CIRCUIT ARRANGEMENT.

ber of iron wires. K is an ordinary telegraph Morse key, by which the train of oscillations is broken up into dots and dashes.

When the first experiments were made with wireless telegraphy a single vertical wire was employed and the spark-gap was included directly in the circuit, as outlined in Fig. 5. The assumed operation of this arrangement is that when the electromotive force at the spark-gap S exceeds the breaking-down point of the air a spark jumps across, heating the air and lowering its resistance, whereupon a series of electric oscillations occur in the vertical wire, which oscillations in turn set up electric waves in the ether.

Theory, however, indicates and practice confirms that the oscillations in a single vertical wire die out rapidly owing to the small capacity of the wire. It was soon perceived, perhaps first by Lodge, that if the oscillations set up in a circuit possessing persistent oscillating qualities could be impressed upon the vertical wire an improvement in the art would follow. To this end a separate, persistent oscillation circuit was arranged, consisting of the spark-gap S, capacity C and inductance L, as in Fig. 4. Here the electrical pressure developed in the secondary of the induction coil or transformer T charges the condensers CC until the pressure breaks down the air-gap at S, when the condenser in a more or less prolonged series of oscillations discharges in the oscillating circuit CSL. In several important systems the spark-gap S is now divided into several small or multiple spark-gaps by means of which the tendency to the formation of an arc is avoided when very high potentials are used. In the Telefunken system the multiple spark-gap consists of a number of metal discs in series and separated from one another by a quarter of an inch of air-space. Each gap is shunted by a small capacity to reduce heat losses.

In virtually all of the practical systems of long-distance wireless telegraphy some form of oscillating circuit apart from the vertical wire is now employed. This oscillating circuit is coupled with the vertical wire either by a transformer, as in the Marconi, Lodge-Muirhead and other systems, or by an autotransformer, as in the De Forest and some forms of the Braun systems. In this way the electrical energy stored in the condensers and the more prolonged oscillations of the oscillating circuit are communicated to the vertical wire, with the result that a train of waves of larger and fairly uniform amplitude is radiated. Since the period of oscillation is proportional to the capacity and inductance of a circuit it is possible by properly proportioning these factors to obtain a desired wave-length. The capacity and inductance of the oscillating circuit is adjusted or tuned so that its period corresponds to that of the vertical wire, whereby the valuable effect of resonance is obtainable. For similar purposes the receiving circuits of several of the best known wireless systems are also provided

with oscillating circuits in tune with the receiving antenna circuit, the latter being attuned to the same oscillation rate as the transmitting circuits. Variable-inductance coils and variable capacities (Leyden jars or condensers) are employed to obtain waves of the desired lengths.

This method of obtaining a desired period of oscillation, and consequently of wave-length, it may be noted, is quite analogous to that in which the rate of oscillation of a tuning-fork and the consequent air-wave may be varied by changing its elasticity or inertia, those properties which in mechanics correspond to electrical capacity and inductance.

The matter of preventing "interference" or clashing of signals between different stations has received much attention from inventors. This interference is akin to the results that follow attempts to send two sets of signals on one Morse telegraph wire. Sometimes the interference on a Morse wire is intentional, as when two or more operators "fight" for the wire; at other times it is unintentional, and in that case is due to the Morse relay at one station being out of adjustment. Similarly the interference is sometimes intentional in wireless telegraphy. In other cases it is not intentional, the detector at the interfering station not being adjusted or not sufficiently sensitive to respond to other sets of electric waves. Hence the operator may unwittingly continue setting up disturbances in the ether that may prevent stations within the influence of his transmitter from transacting business.

Several inventors have claimed that by means of special tuning apparatus and by the selection of widely varying wave-lengths, this clashing of signals in wireless telegraphy can be prevented. The means employed consists in adjusting the oscillating circuits to a given wave-length, in which case the system acquires a tendency to respond readily to waves of its own frequency or wave-length, and less readily to waves of different lengths. Experiments and actual practice have shown that this result can be obtained to a considerable extent, but not entirely, for when the "foreign" waves are of sufficient strength or do not vary sufficiently in frequency they still affect the sensitive detector in the tuned circuit.

To cite a case in point. In the vicinity of New York city there are two powerful wireless stations about two miles apart. One of these stations (A) uses normally a wave-length of 320 metres. The other station (B) was also tuned to this wave-length, and when the first station (A) was transmitting the second station (B) was unable to receive signals from a sister station (C) twenty-six miles distant. By increasing the wave-length to 930 metres at stations B and C they were able to communicate with one another without regard to station A, interference being almost entirely absent. With a wave-length of about 600 metres the disparity was not sufficient to avoid interference.

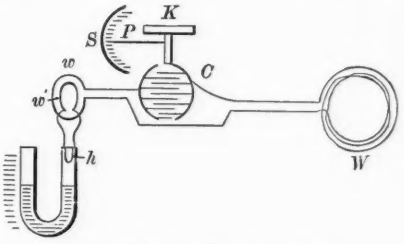


FIG. 6.—DONITZ WAVE METER.

It may be remarked in this relation that when the telephone is used as a receiver in wireless telegraphy it is found that entire freedom from interference is not necessary, inasmuch as when two or three wireless messages are being transmitted simultaneously a skilful operator is able to "work through" the interference. That is he picks out the message intended for his station by simply disregarding the signals intended for other stations, virtually as two persons on opposite sides of a room may carry on a conversation between themselves notwithstanding that other conversations are going on in the same room. The ability to pick out the signals for a given station in this way is facilitated by the fact that usually the various transmitters have more or less different oscillation or wave-length rates and thus produce sounds of different pitch or tone in the telephone receiver. As an illustration of this it may be remarked that over fifteen years ago the writer participated in experiments in which three different tones, broken up into the letters of the Morse alphabet, were employed in the transmission of three messages simultaneously over one wire from New York to Chicago, the respective tones being heard in telephone receivers. The messages were received by three operators, each of whom directed his attention exclusively to one of the tones, disregarding the other tones.

In other instances interference from "foreign" stations is also measurably prevented by reducing the sensitiveness of the detector and increasing the power of the transmitter.

To prevent outsiders from reading or, so to speak, from overhearing messages, the British naval officials have resorted to the employment of short vertical wires and low-power transmitters in conjunction with sensitive transmitters for use among vessels of the same fleet. By this means the effective radiating distance of the electric waves is obviously diminished.

To facilitate the measurement of wave-lengths for wireless telegraph purposes several wave meters have been devised and are now used in ordinary practice. One of these, the Donitz (Fig. 6) wave meter, consists of a coil of wire W about eight inches in diameter that may be placed in the field of force of the oscillating circuit to be measured. This coil is in series with an adjustable oil condenser C and another very small coil of wire w. This latter coil is placed in inductive relation to another smaller coil w' in the circuit of which is a small "heat" wire h, contained in one of the ends of a U-shaped glass tube, partly filled with a colored liquid. The condenser consists of two series of semi-circular metal plates, one of which series is fixed and the other movable into or out of juxtaposition with the fixed plates. The movable series is operated by a knob K on the cover of the box containing the plates, and a pointer P attached to the knob moves around a graduated scale S on the cover. The condenser is adjusted until the circuit is in

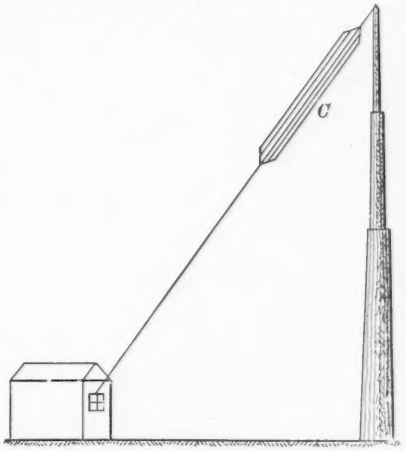


FIG. 7.—SLABY-ARCO CAGE AND MAST.

resonance with the oscillations of the external oscillating circuit, which will be when the heat-wire, by expanding the gas in the tube, displaces the liquid to a maximum height. The pointer at this time will be opposite a point on the graduated scale which either directly or by the use of a prepared curve will indicate the frequency or wave-length of the oscillating circuit under measurement.

Examples of several methods of ar-

ranging the antennæ on shipboard and at shore stations are given in Figs. 7, 8, 9. Fig. 7 illustrates the Slaby-Arco cage arrangement for capacity. The cage *c* is about twenty feet in length, starting from the top of the mast and consists of six or eight wires held apart by hoops. The diameter of the cage is about one foot. A single wire proceeds from the lower end of the cage more or less obliquely to the operating room. In some of Fessenden's stations he employs a horizontal cage about forty feet long and three feet in diameter, supported between the tops of two high masts.

An arrangement of the vertical wires at some of the De Forest stations is outlined

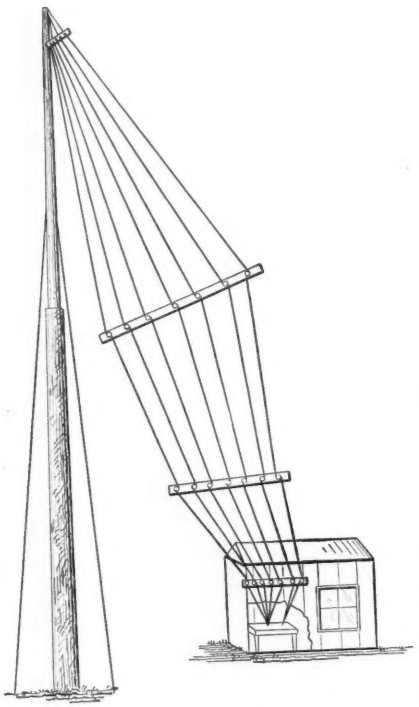


FIG. 8.—DE FOREST SYSTEM SHORE STATION.

in Fig. 8. Here seven wires are used and are held apart by insulating spreaders.

In Fig. 9 a shipboard arrangement of the vertical wires as employed by Marconi is outlined. Horizontal wires from mast to mast are also used by the De Forest and Telefunken companies on shipboard installations.

The number of wires and the height of the masts or towers vary greatly with different stations. In some cases forty and more wires are employed with masts and towers over 200 feet high.

In the large majority of wireless telegraph installations extant the vertical wire is "grounded," or "earthed." That is, the lower terminal of the antenna is attached to metal plates embedded in the earth, or, in the case of shipboard installations, to the iron hull of the ship. For ordinary service this arrangement of the antenna has been found satisfactory, but when tuned circuits are resorted to the direct earth connection is found to possess some disadvantages. For example, variations in the resistance of the earth are calculated to introduce disturbances in the tuning. For this and other technical reasons, such as the elimination of atmospheric interference, a non-earthed aerial is sometimes employed. Thus in one of the Lodge-Muirhead installations, namely at Heysham Harbor, England, the following non-earthed plan has been adopted. Four masts, eighty feet apart and eighty feet in height, are arranged in a square. These masts support at their top a network of wire—in all 6,400 square feet of netting. At the foot of the masts there is a similar network of wire, termed the "counterpoise," upheld by porcelain insulators at a height of three feet from the ground, and carefully insulated therefrom. This arrangement is in successful operation between the shore at Heysham Harbor on the Midland railway and the steamer Manxman. In this country also a somewhat similar arrangement is employed in the Stone wireless telegraph system, and on different occasions De Forest has successfully employed non-earthed aerials at his receiving stations for distances of 100 miles. Wildman also in Alaska, because of the inability to obtain a good earth owing to the frozen condition of the earth, has successfully employed a counterpoise or wire netting in some of the work for the United States signal corps.

Successful long-distance wireless telegraphy has not yet been accomplished without the use of a direct earth connection of the transmitting aerial wire. In this country the courts have upheld the Marconi patent covering the grounded antenna in combination with an imperfect contact such as the filings coherer. This fact may serve as an incentive to other inventors to develop still further the non-earthed aerial or counterpoise.

Among the interesting tests with wireless telegraphy during the past year are those relating to long-distance transmission overland. In Europe by the Slaby-Arco system communication has been held in both directions between Kariskrona, Sweden, and Berlin, Germany, a distance of 280 miles. Signals have also been transmitted in one direction by the Marconi system from Poldhu, England, to Gibraltar, with several hundred miles of intervening land. In the United States by the De Forest system signals have been transmitted between Key West, Fla., and Chicago, Ill., a distance overland of about 1,200 miles.

Within the past year the question of governmental supervision of wireless telegraphy has taken shape in Great Britain by the passage of a bill in Parliament which gives the government complete control of wireless telegraphy in that country and over the ships flying its flag. All the other European powers had already exercised supervision of this art. In the United States an interdepartmental board, consisting of representatives of the army and navy, was appointed by the President to consider the entire question of wireless telegraphy in the service of the national government. As a result of this board's report and recommendations the United States government coastwise wireless telegraph stations have been placed in the control of the navy department. This action at once places in the hands of the

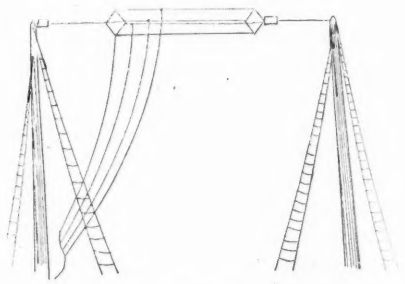


FIG. 9.—MARCONI MAST-HEAD ARRANGEMENT.

navy twenty-six wireless telegraph stations, and the installation of sixty additional stations is under consideration. Of the stations already in operation seventeen are on the Atlantic coast, four in the Carribean sea waters, three on the Pacific coast and two in the Philippine Islands. All of the coastwise stations are fully manned and will be open day and night. They will exchange messages with passing vessels free of charge until further notice, but such messages will be subject to the usual land telegraph tolls. Storm warnings will be given to passing vessels and storm signals will be displayed from lighthouse wireless stations. One of the conditions of this free service is that all vessels availing of it must transmit and receive all government messages free and these shall have preference in transmission. The rules governing this service advise that no attempt be made to call up a station at a distance exceeding seventy-five miles; also that messages be not transmitted at a greater speed than twelve

words per minute in the present state of the art.

The coastwise stations are allotted "calls" as in the case of ordinary telegraph offices. Thus the wireless call for the navy yard, Portsmouth, N. H., is "PC"; the navy yard, Mare Island, Cal., "TG."

The rules do not state how passing vessels are to be called from shore. To complete the arrangement it would seem that every ship equipped with a wireless telegraph outfit should be allotted a registered telegraph call. This will doubtless ultimately involve allotting three or four letters to a call, as probably it would lead to confusion to assign reverse calls, such as "AB," "BA," to different vessels.

It does not yet appear that any designating "call" has been set apart universally as a signal of distress or when the call of a vessel or station is unknown. The signal "RA" has been used for the last-named purpose in the United States naval service and might perhaps be adapted to this purpose in wireless telegraphy with advantage. These and other matters of corresponding import will no doubt receive attention at the next international wireless telegraph convention.

The Continental Morse telegraph alphabet is used in wireless telegraphy by perhaps all operators, excepting, perhaps, the operators of the De Forest and other American wireless telegraph companies. Uniformity, in respect of the alphabet employed in this art, would obviously be of advantage in peace times. It is well known that the American Morse telegraph alphabet is faster than the Continental Morse, but the fear of errors due to the spaced letters in the American Morse code, that undoubtedly is warranted in automatic transmission of the Wheatstone type, but which is not altogether warranted in manual Morse transmission, has led to the almost universal adoption of the Continental code in all countries outside of the United States, Canada, and possibly some of the South American states.

While very long-distance wireless telegraphy, such as the regular transmission of messages across the Atlantic, is not yet a commercial proposition, still there is no longer any question as to the practicability of wireless telegraphy. As a means of communication between ships at sea and ships and the shore it is indeed already recognized as indispensable. Hundreds of sets of wireless telegraph outfits are now in daily operation on lightships, lighthouses and on naval and mercantile vessels in all parts of the world. The important operations by the De Forest wireless system in the transmission of war news from the edge of the war zone in the Far East are still fresh in the public mind, and probably nothing previously accomplished in wireless telegraphy demonstrated so clearly the practicability and usefulness of this new art. After two years spent in negotiations the British post office department has concluded an arrangement with the Marconi International Communication Company which provides for the interchange of wireless telegraph messages to and from passing Atlantic liners. So far there are six Marconi wireless stations on the coast of England and Ireland which will be affected by this arrangement, namely, North Foreland, Niton and the Lizard, on the English coast, and Rosslare, Crookhaven and Malin Head on the Irish coast. Similar arrangements have been for some time in operation between the post-office and telegraph departments of Germany, France and Italy, whereby messages have been interchanged with vessels and wireless stations along the coast for transmission on the land lines. The large telegraph companies of the United States and Canada also exchange messages with the various wireless telegraph companies. A number of Marconi stations, extending from Quebec to the straits of Belle Isle on the river and Gulf of St. Lawrence, a distance of over 320 miles, have also been in successful operation for some time to the great convenience of the maritime interests of that somewhat dangerous marine highway. By means of these wireless stations steamships are enabled to communicate with the shore for several days before arriving at, and after leaving, Quebec. The installation of an important chain of twelve Fessenden stations along the Amazon river 1,000 miles from its mouth was recently started to supplant the subaqueous cables now in use along the course of that river, much difficulty having been found in keeping these cables in reliable operation. It seems, however, that after these stations had been placed in operation the Brazilian government declined to grant a concession for the operation of the wireless circuit. The company had a concession to work in the states of Para and Amazon, but not between these states. Hence the circuit has had to be abandoned.

It is evident that before a chain of wireless telegraph stations can be operated to the best advantage for the relaying of business from one station to another the art must have advanced to the point where messages may be received and transmitted simultaneously from a given station. Until this result is accomplished it is evident that much time will be lost, inasmuch as, for instance, the second station of the chain can not begin to transmit to the third station until the second station has ceased receiving from the first station, and so on. While as previously remarked, it is now possible, by tuning the receiving circuit, to select certain incoming waves to the partial exclusion of other incoming waves, it does not appear that it has been found commercially practicable to so adjust the receiving circuits as to eliminate the powerful waves of an adjacent transmitter.

The Slaby-Arco and the Braun systems, now combined under the name of the Telefunken Wireless Telegraph Company, are in operation on many of the German and some of the Russian warships. This system is also in use in a number of the coastwise stations and on many of the vessels of the United States navy. The Rochefort method, which differs only in details of apparatus from some of the better known systems, is in extensive use in the French navy. The De Forest system is now, or is being, installed on vessels of the Mallory line, the Red D line, the Quebec steamship line, the Ocean steamship line plying between New York, Brooklyn and Southern United States ports and Bermuda and South American ports. The Fall River line of steamboats running between New York and Fall River, Mass., are also equipped with wireless telegraph outfits, and numbers of ocean-going tugs, steam yachts, etc., here and in Europe, are equipped with wireless outfits.

Among the notable permanent stations installed within the past year and that are now in practical commercial operation may be mentioned the De Forest wireless circuit between Port Limon, Costa Rico and Bocas del Terro, a distance of seventy miles. Also the wireless circuit established for the United States army signal corps by Captain Wildman from Saint Michael to Safety Harbor, Alaska, a distance of 107 miles. Since the installation of this last mentioned circuit in 1904, commercial business to the extent of about $1,200 per month has been regularly transacted, and in all over 1,000,000 words have been transmitted without an error having been charged against the system; truly a creditable record.

The installation of these shipboard and shore stations, together with those already specifically mentioned in the article, while but a fraction of the total wireless equipments now in operation, indicates clearly the laudable action now being taken in all parts of the globe to bring seafaring people into closer communication with each other and with terra firma than has ever before been the case, or, indeed, ever could have been prior to the advent of modern wireless telegraphy. The wisdom and humanity of this action are being almost daily exemplified in the prevention of accidents and in the saving of lives in jeopardy at sea. No better illustration of this statement could be offered than the recent succor of thirteen men from the foundering lightship No. 58 at Nantucket shoals, upon information transmitted to shore from the lightship by means of wireless telegraphy.

Auxiliary Reversing Poles for Large Continuous-Current Dynamos.

By H. M. Hobart.

IN THE design of large continuous-current dynamos for steam-turbine speeds it becomes necessary to introduce auxiliary windings in order to obtain satisfactory commutation. Without these provisions it becomes impossible, with fixed brush position for all loads and with carbon brushes, to avoid proportions leading to reactance voltages which would occasion sparking.

The most satisfactory solution from the commercial standpoint consists in the employment of auxiliary poles intermediate between the main poles. These auxiliary[1] poles are furnished with windings carrying the main current, the windings being proportioned to provide a magnetomotive force at any and every load, not only sufficient to neutralize the armature magnetomotive force but to provide a field of sufficient intensity and extent and of suitable direction to approximately neutralize the reactance voltage set up in the armature coils while short-circuited under the brushes.

Such designs afford the best means yet available for securing good commutation in large steam-turbine-driven continuous-current dynamos. The principle is also coming to be widely used in small continuous-current dynamos and motors, not only for high but also for moderate speeds. In cases where heating is the limit of output, and not sparking, such designs are more expensive and less efficient, and their use is not in accordance with sound engineering practice.

Auxiliary commutating poles are the more suitable the higher the speed, voltage and output. When all three of these factors are high, a design with auxiliary windings will alone permit of a satisfactory result. When all three factors are low, a design with commutating poles would be more expensive and no better as regards commutation or in any other respect than a correct design without them. For intermediate cases a careful preliminary comparison of alternative design is often necessary.

For a 750-kilowatt, 250-volt, 1,500-revolutions-per-minute design, auxiliary poles should be employed, as an ordinary design with good commutation is impossible. For 250-kilowatt machines for 250 volts and 1,000 revolutions per minute, while designs with commutating poles are much cheaper and more satisfactory, good designs without them are still practicable.

Coming down to 100-kilowatt machines for 250 volts at 1,000 revolutions per minute, the advantage which commutating-pole designs have over ordinary designs is but slight. At a somewhat lower output or speed there would, for 250-volt designs, be no choice. For still lower outputs and speeds, for 250 volts, the commutating-pole design becomes the more expensive. For a 100-revolutions-per-minute design, for 250 or even 500 volts, the preferable design would be without commutating poles, even in large capacities. At 200 revolutions per minute and 500 volts, commutating poles are desirable from, say, 400 kilowatts upward, and for 200 revolutions per minute and 250 volts from, say, 600 kilowatts upward.

Of course, such statements can only be general and the preferable design depends very greatly upon the precise conditions for which the machine is to be used. In general, however, when heating and not commutation is the limiting consideration, the cheapest and best design will be without commutating poles, and vice versa when commutation is the limit.

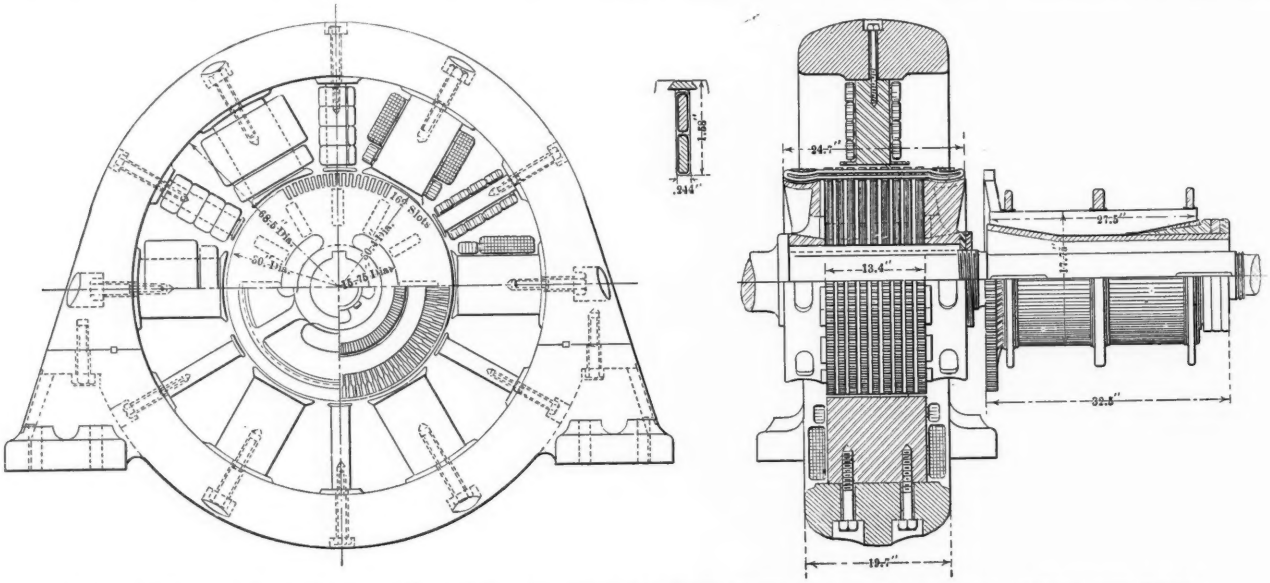


FIG. 1.—GENERAL ARRANGEMENT OF HIGH-SPEED, CONTINUOUS-CURRENT GENERATOR, WITH AUXILIARY COMMUTATING POLES, 750 KILOWATTS, SIX-POLE, 250 VOLTS, 1,500 REVOLUTIONS PER MINUTE.

Commutating poles are generally preferable to Déri windings on the score of the mechanical superiority and lower labor cost associated with the windings of the former type.

In the following specification and in the diagrammatic sketches in Figs. 1 and 2 are given the rough outlines for the electromagnetic design for a 750-kilowatt, 250-volt continuous-current generator for a speed of 1,500 revolutions per minute.

This rough design, while in no sense to be taken as a model to be copied, nevertheless serves our present purpose of illustrating the considerations entering into the design of large continuous-current dynamos with reversing poles.

As will be seen from an examination of the design, a high periodicity (in this

[1] Sometimes called "reversing" or "commutating" poles.

case seventy-five cycles per second) is unavoidable. As a fairly high core density is also necessary in order, in spite of the restricted diameter, to provide access for sufficient air to the interior of the core, thence to flow radially outward through the ventilating ducts, a rather high core loss per pound of armature laminations must necessarily be permitted. Liberal provision of radial ventilating ducts must therefore be made as the total rate of generation of heat in the armature per square inch of peripheral radiating surface will be much higher than is otherwise permissible.

The main problem, however, relates to the design of the commutator. Notwithstanding recent very encouraging progress in the development of improved carbon and graphite brushes and in improved brush-holders, a peripheral speed of thirty-five metres (115 feet) per second is as high as it is yet desirable to go. In order to get sufficient radiating surface to prevent excessive temperature rise, the commutator, as will be seen from the example, is of great length and correspondingly awkward as regards mechanical design, the more especially so with respect to providing internal ducts for the circulation of air. As a compromise between the mechanical and electrical difficulties, a much higher temperature rise than would be preferred has been allowed in this design. The temperature rise will be some sixty degrees centigrade. Some designers would have shortened the commutator by resorting to copper brushes. This, in the writer's opinion, is not advisable. The newer types of graphite brushes indicate very encouraging progress toward lower-friction coefficients and I^2R contact losses and this progress, when thoroughly verified by time tests, can gradually be followed up by decreased commutator lengths.

SPECIFICATION OF 750-KILOWATT, 250-VOLT, 1,500-REVOLUTIONS-PER-MINUTE CONTINUOUS-CURRENT GENERATOR.

ARMATURE.

The core-plates are stamped in one piece from plates not more than 0.5 millimetre thick and are threaded directly on to the shaft, as the required shaft diameter does not permit of an armature spider. The slot conductors are kept in place by wedges which in turn are retained by recesses in the sides of the slot and by binding bands. The end connections are carried on a specially shaped end-plate, which is so curved on its surface as to permit of the binding wire holding the end connections being heaped toward the centre.

COMMUTATOR.

The construction of the commutator differs rather radically from that customary for slow and moderate speed designs.

The segments are built up with the intervening layers of mica and clamped together. Circumferential mica bands are then placed at the middle and at the two ends, and three steel rings are shrunk on over the mica. The interior contour is then machined and the commutator is secured in place on the shaft by cones forced in by end rings. The external surface is then turned.

BRUSHES.

The brushes are of carbon or, preferably, of graphite of low contact and radial resistance and high transverse resistance. They are carried in holders of a suitable type to prevent vibration and chattering at the high peripheral speed employed.

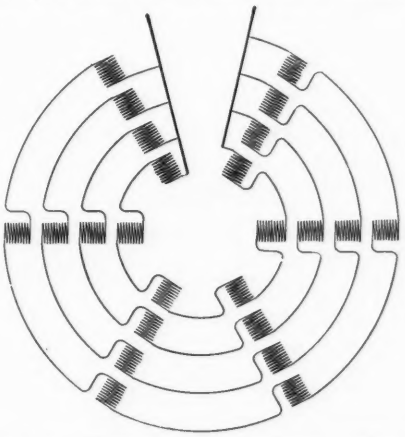


FIG. 2.—750-KILOWATT, HIGH-SPEED CONTINUOUS-CURRENT GENERATOR. DIAGRAM OF WINDING FOR AUXILIARY FIELD CIRCUIT CONNECTIONS.

MAGNET FRAME.

The yoke is made from cast iron. This is employed chiefly on account of the greater rigidity and stability thereby obtained as compared with a cast-steel yoke of equivalent magnetic capacity.

AUXILIARY COMMUTATING POLES.

The main current of this machine is equal to 3,000 amperes. Taking 1,000 amperes through a diverting shunt leaves 2,000 amperes, which, if carried through the coils of the six auxiliary poles in a single series, would require about five turns per pole, and each turn would be of inconveniently large cross-section. It is also objectionable to use many turns in parallel owing to the difficulty of obtaining good contact at the connections. An alternative would be to put the spools in parallel, but unless very carefully adjusted the different windings would be of unequal resistance, resulting in varying strengths of current in different spools.

To overcome these difficulties the following arrangement of winding has been adopted: each spool is subdivided into four sections wound with five and one-half turns of copper strip. The details of the winding scheme are shown diagrammatically in Fig. 2.

The winding is arranged in four parallel circuits with 500 amperes per circuit. Each circuit contains one section of winding on each pole, or thirty-three turns in series. By this arrangement the convenience of parallel winding is obtained without incurring the liability of having varying strengths of field on the different commutating poles, since any inequality in the current in one section is shared by all the poles.

DESIGNING DATA FOR 750-KILOWATT, 250-VOLT, 1,500-REVOLUTIONS-PER-MINUTE CONTINUOUS-CURRENT GENERATOR.

Number of poles	6	
Kilowatts output at rated load	750	
Speed in revolutions per minute	1500	
Frequency in cycles per second	75	
Terminal voltage	250	
Amperes output at full rated load	3000	

GENERAL DIMENSIONS—ARMATURE.

External diameter of laminations	30	ins.
Diameter at bottom of slots.	26.8	"
Internal diameter of laminations	15.75	"
Cross length of core between flanges	13.4	"
Number of ventilating ducts	8	
Width of each duct	0.395	ins.
Percentage insulation on core plates	10%	
Effective length of core	9.2	ins.
Number of slots	162	
Depth of slot	1.58	ins.
Width of slot stamped	0.256	"
Width of slot assembled	0.244	"
Average width of tooth	0.29	"

MAGNET CORE.

Length of pole face parallel to shaft	13.4	ins.
Mean length of pole arc	9.4	"
Width of magnet core parallel to shaft	5.7	"
Width of magnet core at right angles to shaft	7.9	"
Thickness of pole shoe at centre of arc	0.394	"
Radial length of magnet core	11	"
Radial depth of air-gap	0.236	"

YOKE.

External diameter	68.5	ins.
Internal diameter	54.5	"

Thickness of yoke	7.1	ins.
Axial width	19.7	"

REVERSING POLE CORE.

Length of pole face parallel to shaft	9.5	ins.
Length of pole arc	2.9	"
Radial depth of air-gap	0.275	"
Width of magnet core parallell to shaft	5.7	"
Width of magnet core at right angles to shaft	2.56	"
Cross-section of core	13.2	sq. ins.

ELECTRICAL DATA.

Number of face conductors	324	
Number of slots	162	
Number of conductors for slot	2	
Style of winding	6-circuit double.	

(A double winding was adopted in order to obtain a sufficiently large number of slots per pole and to obtain a more convenient dimension of armature conductor.)

Number of circuits through armature	12	
Total amperes from commutator	3000	
Amperes per circuit	250	
Mean length of one turn	74	ins.
Turns in series between brushes	13.5	"
Total length of conducting path between brushes	995	"
Height of bare conductor	0.59	"
Width of bare conductor	0.157	"
Cross-section of one conductor	0.093	"
Cross-section of all parallel conductors	1.12	sq. ins.
Resistance of armature windings from positive to negative brushes at 60 degrees centigrade	0.0007	"

COMMUTATOR CALCULATIONS.

Commutator diameter	17.75	ins.
Number of segments	162	
Thickness of segment + insulation at periphery	0.344	ins.
Total length of commutator	27.5	"
Number of sets of brushes	6	
Number of brushes per set	12	
Width of brush	1.16	ins.
Length of arc of contact	1.16	"
Contact surface per brush	1.35	"
Amperes per sq. in. of brush contact surface	61	
Peripheral speed of commutator	35.4	
Reactance voltage	15.5	

MAGNETIC DATA.

Terminal voltage at rated output	200	volts
Total induced voltage at rated output	256	"
Flux entering armature per pole at rated full load, megalines	6.32	
Leakage factor for main magnetic circuit	1.35	
Flux generated per pole at rated full load, megalines	8.5	

AMPERE TURNS REQUIRED FOR FULL LOAD VOLTAGE AT NO LOAD.

	Density in Lines per Square Inch.	Total Ampere-Turns per Pole.
Armature core	62000	68
Armature teeth	142000	2200
Air-gap	50500	3760
Magnet core	95000	1050
Magnet yoke	34500	1130
Total ampere turns for full load voltage at no load		8208
Ampere turns provided by shunt winding		8000
Ampere turns provided by series winding		2400

MAGNETIZING WINDING CALCULATIONS—SHUNT SPOOL.

Axial length of winding	7.1	ins.
Depth of winding	2.36	"
Gauge number of conductor.	B.W.G. 12	
Amperes in the winding	8.2	
Current density in amperes per sq. in.	370	sq. ins.
Watts lost per spool	242	
Weight of copper per shunt spool	131	lbs.

SERIES SPOOL.

Dimensions of conductor	1.57×0.197	ins.
Number in parallel	6	
Total cross-section	1.86	sq. ins.
Number of turns per spool	1.5	
Current in winding	1600	
Current density in amperes per sq. in.	860	
Watts lost per spool	79	
Weight of copper per spool.	43	lbs.

REVERSING POLE WINDING.

Number of sections of winding	4	
Turns per section	5 1-2	
Dimensions of conductor	1.18×0.177	ins.
Cross-section of one turn	0.42	ins.
Watts lost per section	57	
Weight of copper per spool (for four sections)	65	lbs.

ARMATURE LOSSES—COPPER LOSS.

Total amperes from commutator	3000	
Resistance of winding from positive to negative at 60 degrees centigrade temperature rise	0.0007	
Watts lost in armature winding	6250	
Weight of armature copper	365	lbs.

IRON LOSS.

Total weight of laminations	1142	lbs.
Flux density in core, kilolines per sq. in.	62	
Periodicity in cycles per sec.	75	
Total core loss, watts	12000	
Friction and windage losses, watts	3000	

HEATING.

Armature watts lost per sq. in.	8	
Commutator watts lost per sq. in.	7.4	
Shunt spool watts lost per sq. in.	0.66	
Series spool watts lost per sq. in.	0.62	
Reversing pole spool watts lost per sq. in.	0.81	

TOTAL LOSSES.

Total constant losses	22782
Total variable losses	16442
Total	39224
Commercial efficiency at full load	95.2%

WEIGHTS OF EFFECTIVE MATERIALS.

Armature copper	365	lbs.
Commutator copper	1210	"
Shunt spool copper	790	"
Series spool copper	258	"
Reversing pole spool copper.	352	"
Armature laminations	1150	"
Magnet cores, cast steel	1760	"
Reversing pole cores, cast steel	187	"
Yoke, cast iron	6500	"
Total weight of effective material	12572	lbs.

COSTS.

Total cost of effective copper.	2760	shillings	($672.00)
Total cost of effective iron	1164	"	($283.00)
Total cost of effective material	3964	"	($955.00)
Total cost per kilowatt	5.15	"	($1.275)

The design above set forth will serve to illustrate certain important points arising in connection with the calculation of machines of this type.

The leakage coefficient must be taken much higher than in the calculation of ordinary designs without reversing poles. Obviously this applies to a greater degree to the magnetic circuit of the reversing poles than to the main magnetic circuit. In the design which we have illustrated the leakage coefficient has been taken equal to 1.35 for the main magnetic circuit and to 1.45 for the auxiliary circuit, for while the leakage flux from the auxiliary circuit has available the large surfaces of the main circuit, the leakage flux from the main circuit is only increased by the small extent caused by the comparatively limited surfaces of the auxiliary poles.

As the exciting coils on the auxiliary poles are mainly required for overcoming the armature magnetomotive force of 6,550 ampere-turns per armature pole, one can not save much copper by employing low densities or short air-gaps in the auxiliary circuits. Especially as regards the air-gap, a deep gap will increase to a much less extent the reactance voltage of the short-circuited coils due to the proximity of the magnetic material of the pole extremity. A deep air-gap will also tend to reduce the core loss and also the noise.

Of less, but still of considerable importance, is the fact that a deep air-gap, under the reversing poles will, by reason of the magnetic material of the pole shoe being further removed from the armature conductors, increase the magnetic reluctance of the inductive iron paths round the short-circuited armature coils and will thus slightly reduce the reactance voltage and in turn the dimensions of the reversing pole.

The calculation of the necessary flux entering the armature from the auxiliary pole is derived in the following way:

Let l = the length of embedded conductor lying within the region of the flux issuing from the pole, *i. e.*, the length of conductor which actually cuts the auxiliary field.

This length will be equal to the breadth of the pole shoe, parallel to the shaft b, multiplied by 1.1 to allow for fringing of the field at pole tips, and by 0.7, because of the total length of a face conductor, only about 0.7 of it is "active" or "embedded" in armature iron, the remaining 0.3 being taken up by air ducts and core insulation. Hence $l = 1.1 \times 0.7 \times b = 0.77\ b$. If S = the peripheral speed of armatures in centimetres per second, and B the average density in the air-gap of the auxiliary pole in centimetre-gramme-second lines per square centimetre, then the rate of cutting of flux by one conductor is equal to

$B \times l \times S$ = centimetre-gramme-second lines per second, and the electromotive force generated in this conductor is

$$\frac{B \times l \times S}{10^8}$$

Since we have two conductors in the short-circuited turn, the electromotive force generated in this turn is equal to

$$\frac{2\ B\ l\ S}{10^8}$$

This electromotive force must be sufficient to neutralize the reactance voltage.

If v the mean reactance voltage

$$= \frac{\text{reactance voltage}}{\frac{\pi}{2}}$$

then we have $v = \frac{2\ B\ l\ S}{10^8}$

Whence $B = \frac{v \times 10^8}{2\ l\ S}$

which determines the requisite flux density at the pole face.

The length of the pole arc of the auxiliary pole is chosen such that during the whole period of commutation a coil shall be moving in the auxiliary field.

It is important that the coil shall be moving in a sufficient field at the moment when its commutator segments are leaving the brushes. The pole arc should cover as many slots as are carrying conductors simultaneously short-circuited by the brush and it is safer to have a larger pole arc than this to allow for any distortion of the auxiliary field which may occur with varying load. An additional allowance is also necessary when there are several segments per slot, as the true diameter of commutation is then constantly swinging back and forth through a small arc.

The total flux crossing the gap per auxiliary pole may now be deduced from the dimensions of the pole face. The total flux generated in the pole is this quantity multiplied by the leakage coefficient referred to above. The total ampere turns required on the auxiliary pole are made up of a number equivalent to the magnetomotive force of the armature and a number of ampere turns sufficient to send the flux across the auxiliary air gap and round the auxiliary magnetic circuit, *i. e.*, through the pole core and teeth immediately under the pole face. As this saturation component of the ampere turns, in the design here given at any rate, is comparatively small compared with the armature reaction component, the total ampere turns on the pole will not be much increased by saturating the pole core to as high a limit as possible, thus reducing the cross-section of pole to a minimum and consequently the peripheral length of the winding and obtaining a minimum weight of copper. Such high saturation has, of course, the objection that the reactance voltage increases directly with the output and so should also the reversing field from the auxiliary pole, but it must be remembered that exact equality need not be maintained at all loads, since a range of residual voltage from one or two volts negative to one or two volts positive, *i. e.*, a total range of, say, three volts, will not suffice to occasion sparking.

The resistance of the diverting shunt is finally adjusted during actual test to such a value as to obtain good commutation at all loads.

There has been a tendency to envelop these very simple calculations in mystery, and the clear exposition of Dr. Breslauer (*Elektrotechn. Zeitschr. Heft* 28, July 13, 1905, p. 640) is therefore especially welcome.

As pointed out by Dr. Breslauer in the article just referred to, the principle involved is very old and is due to Menges, Swinburne, Fischer-Hinnen and others. Dr. Breslauer points out that Menges's patent was granted in 1884 and that Fischer-Hinnen's descriptions date from 1891.

Toledo, Port Clinton & Lakeside Railway.

One of the most populous and productive districts of northern Ohio, namely, the section lying between Toledo and Marblehead, will be provided this season with better transportation facilities than it has known at any time heretofore. This comes about through the completion at Port Clinton of the new power-house of the Toledo, Port Clinton & Lakeside Railway, which is designed to furnish alternating current sufficient for the present heavy needs of the line.

The equipment consists primarily of two horizontal, heavy-duty, cross-compound condensing Allis-Chalmers engines, to which are direct-connected two 800-kilowatt Bullock alternating-current generators delivering current at 375 volts, three-phase, twenty-five cycles. The engines are designed for a normal load of 1,280 indicated horse-power when operating at about twenty-six-inch vacuum and 150 pounds.

The current from the generators is led through the switchboard to three delta-connected, 500-kilowatt, 375/20,000-volt, oil-filled, water-cooled Bullock transformers, which deliver current to the transmission line at 20,000 volts. This line is intended to supply power to three substations, located at suitable and convenient points along the line.

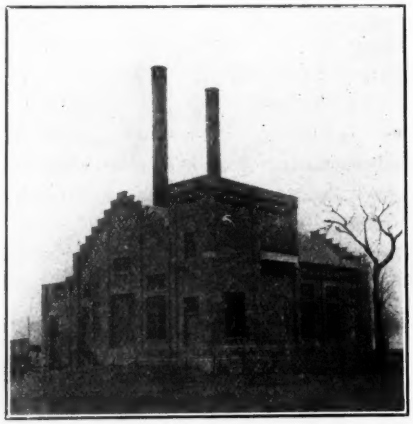
There is also a substation in the main power-house consisting of a 400-kilowatt rotary converter, three-phase, twenty-five cycles. Provision has been made for a second converter of the same rating to be placed there later on. The current applied to these converters will be taken from the main generator bus-bars with suitable connections. The rotary converters in the different substations will receive current from the 20,000-volt transmission line through step-down transformers. The converters will be compound wound.

The main station also contains two exciter units, consisting of two fifty-kilowatt, 125-volt, compound-wound Bullock generators, direct-connected to two simple high-speed engines; each exciter unit is of sufficient capacity to supply exciting current to both alternating-current generators and also furnish enough power for station lighting, etc. Thus an exciting unit is always held in reserve.

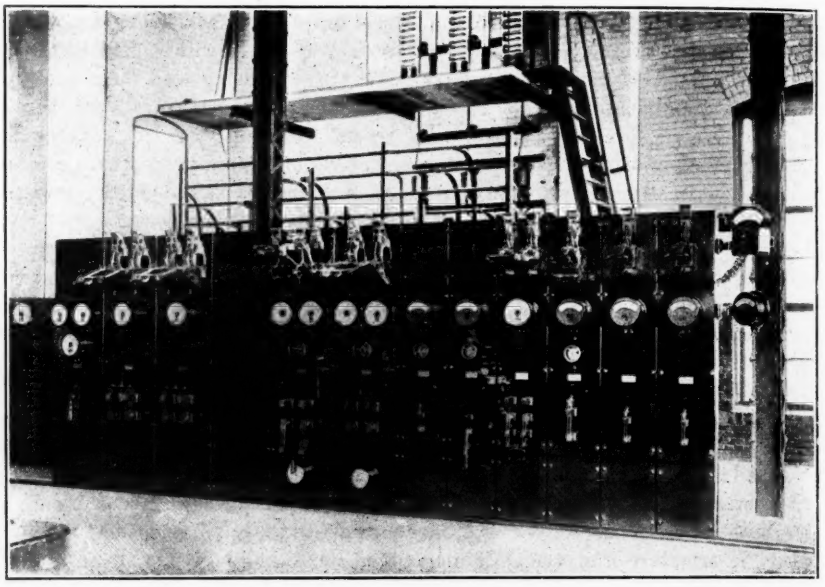
The switchboard equipment consists of the following panels: one high-tension panel, two exciter panels, two transformer panels, one alternating-current rotary panel, two generator panels, one direct-

current rotary panel, two feeder panels. All except the high-tension and exciter panels are equipped with automatic circuit-breakers.

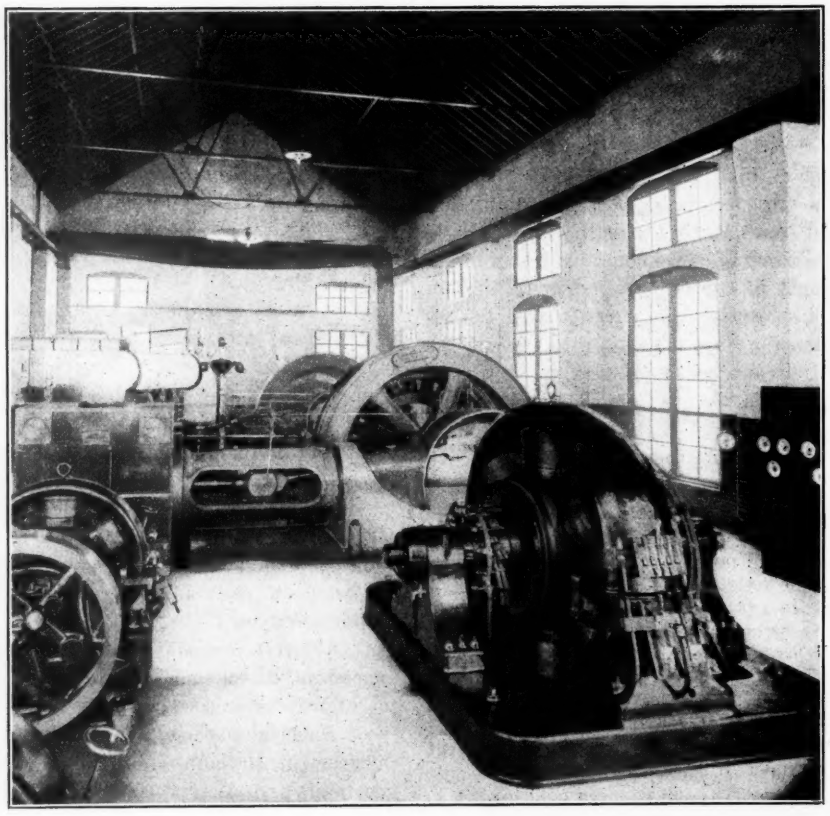
The outgoing high-potential lines pass through a hood, extending outside the building about two and one-half feet and about forty feet from the ground; this hood is so constructed that it is thoroughly weatherproof. The leads pass downward through suitable insulators and the bottom or floor of the hood to an anchorage five feet below. This anchorage is fastened on the outside of the building wall and the leads from it pass directly on to the main pole line.



EXTERIOR OF PORT CLINTON POWER-HOUSE.



SWITCHBOARD, PORT CLINTON POWER-HOUSE.



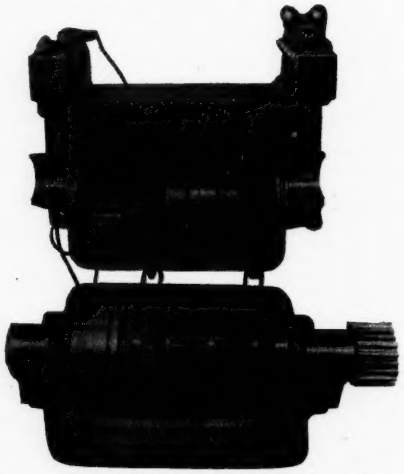
INTERIOR OF POWER-HOUSE, TOLEDO, PORT CLINTON & LAKESIDE RAILWAY.

The inside run of high-potential wiring is designed to be as short as possible, extending only about twenty-five feet from the high-potential side of transformers to the anchorage hood.

Directly beneath the three 500-kilowatt transformers in the basement is located a large metal tank of sufficient capacity to receive the entire quantity of oil required for all transformers and rotary reactive coils.

The large cables running from generators, rotaries, exciters and transformers to switchboard are run in the basement and are substantially mounted on suitable porcelain metal-rack insulators.

At present a single three-phase transmission line is constructed which consists of a No. 6 B. & S. gauge copper conductor. Allowance has been made for a second three-phase line, which will be taken from a common high-potential bus-bar. This second line will eventually be used to take care of the new line extension into Lakeside.



BULLOCK R-50 RAILWAY MOTOR, USED ON CARS OF THE TOLEDO, PORT CLINTON & LAKESIDE RAILWAY.

The boiler equipment consists of four 400-horse-power Erie water-tube boilers in batteries of two and equipped with steel stacks. These boilers supply steam at 150 pounds gauge pressure to main engine and auxiliary apparatus.

The water supply is taken from lake Erie by gravity through a twenty-four-inch pipe, a distance of about 200 feet. This

twenty-four-inch intake terminates at a large well outside of the building. From this well the main suction connections are made to pumps, condensers, etc. Condensers are of the Tomlinson barometric type.

The station is a plain brick building with pitched slate roof and steel trusses. It has a large area of glass window surface. A second row of windows is placed sufficiently high to permit a large amount of ventilation. The station contains a fifteen-ton, hand-operated traveling crane, which has a lift of about twenty-five feet.

The motors used on the present car equipments are of the Bullock (Allis-Chalmers) R-50 type designed for a minimum gauge of four feet eight and one-half inches. They are of liberal design, with ample bearings, and particularly adapted to interurban service. Following is the description given by the manufacturers: "This motor is rated at fifty horse-power, though it is capable of delivering a greater output without overheating. It has a continuous capacity of forty-five amperes at 500 volts, showing no more than seventy-five degrees centigrade rise in shop test. The field frame is of steel casting, divided horizontally through armature and axle bearings. A liberal centre distance is allowed between these bearings, so that a maximum axle of six inches diameter may be used. The pole-pieces are of laminated iron secured to the frame by through bolts. There are four poles, each provided with a coil, which is securely held in place by the projecting tips of the pole-pieces. The pole-pieces are provided with ventilating ducts which register with the ducts in the armature, allowing air to circulate through the pole-piece and around the coil. The armature core is built up of soft steel laminations annealed after punching. The coils are machine wound and thoroughly insulated; they fit accurately in the slots and are held down by band wires which are well below the surface of the core. The commutator is eleven and one-half inches diameter and four and one-quarter inches face. It is built up of hard-drawn copper bars and insulated with the best mica. The commutator has a wearing depth of about seven-eighths inch. The brush holders are of cast brass secured to a specially treated wood block. This block is in turn bolted to the end of the upper field frame fitting in an accurately babbitted seat. Each holder is secured to its block independently of the other and carries two carbon brushes, an independent pressure finger is provided for each brush. The bearings are of cast iron with babbitt lining. The pinion end armature bearing is three and one-half inches in diameter and nine and one-half inches long, and the commutator bearing three inches in diameter and seven and one-quarter inches long. The axle bearings are five and one-half inches in diameter and nine and one-half inches long.

"Cast-steel cut gears of split pattern are used. They are of teeth No. 3 diametral pitch and five inches face. The pinions are of forged steel, fit the armature shaft on a taper seat and are securely keyed to same. The gear ratio is twenty-four to sixty-five. Lugs are provided on the top field frame for bolting to the suspension bar.

"The controller used is of the series parallel type. The main drum makes the rheostatic and motor combination for the four motors. The reverse drum is provided with contacts for each motor and is interlocked with the main drum. A cutout switch is provided for cutting the motors out of circuit. The cutout switch can be thrown, without removing the controller cover, by using the reverse lever. A special main handle is used requiring at least a short stop at each point when feeding it. There are seven points in series and five in multiple. A magnetic blowout is used to protect the contacts. The arcing is also reduced at the open circuit position by inserting an extra section of resistance before breaking."

The entire electrical equipment of the main station, substations and cars was furnished by the Allis-Chalmers Company, Milwaukee, Wis., the power plant complete having been installed by it. Building the road itself was the work of the Toledo Interurban Construction Company, by whose chief engineer, Mr. T. B. Wickenden, the line was laid out. Mr. Wickenden also supervised details of construction work, including the erection and equipment of the power and substations.

An Interesting Exhibit of the Moore Electric Light.

A feature of the recent electrical exhibit at Madison Square Garden, New York city, was the illumination of the corridor of the Garden by a large Moore vacuum tube light. This was the largest Moore lamp yet erected, and, in consequence, the largest vacuum tube lamp which has ever been made. The installation of this lamp was a notable feature in electrical illumination during the year just closed.

The lamp was in the form of a large rectangle, about six feet out from the walls, and was supported by fixtures holding it three feet below the ceiling. It was operated normally at about fifteen candle-power to the foot. The tube was 157 feet long and one and three-quarter inches in diameter, so that the total candle-power may be estimated at 2,350.

It is stated that the efficiency of this tube is about one and one-half watts per candle. The lamp was made in ten-foot sections, welded together at the Garden. The ends of the tube were carried to a small steel terminal box located just inside a side room, so that there was no wiring whatever connected with the light. The voltage of the supply system was 208 at sixty cycles. The terminal box contained a small raising transformer, the secondary circuits of which were connected directly to the glass tube.

Mr. Moore has discovered, he says, certain non-metallic, gaseous conductors, derivable principally from vegetable matter, which permit him to maintain the candle-power of his lamps for an unlimited time, and which also enables him to control the color radiated. He is thus able to obtain a white light, and the form of the lamp gives a very desirable, even distribution throughout the room in which it may be installed.

United Engineering Society.

At a meeting of the board of directors of the American Institute of Electrical Engineers, held on December 15, Mr. John W. Lieb, Jr., was appointed a trustee to represent the Institute for a term of three years upon the board of trustees of the United Engineering Society. Mr. Lieb at the same time was made a representative of the Institute on the building committee. He succeeds Dr. Schuyler Skaats Wheeler, who, by reason of his recent election to the presidency of the Institute, resigns from these other bodies. After the annual meeting of the United Engineering Society in January the representation of the American Institute of Electrical Engineers will consist of Charles F. Scott, Bion J. Arnold and John W. Lieb, Jr.

Electrical Extension in Canada.

Consul Worman, of Three Rivers, Quebec, reports that the North Shore Power Company has been absorbed by the Shawinigan Water and Power Company. Shawinigan falls, where this company has its works, ranks next to the falls of Niagara in importance as a Canadian water power. At this time about one-tenth of its capacity is being utilized. The company furnishes light and power to the cities of Three Rivers and Shawinigan, and to the towns of Grand Mere, Sorel, Berthier, Lanoraie, L'Assomption and Montreal. The absorption of the North Shore Power Company by the Shawinigan company means the reorganization of that company's affairs and the broadening of its enterprises.

The Illuminating Engineering Society.

The Illuminating Engineering Society was formally organized at a meeting held at the Hotel Astor, New York city, on Wednesday evening, January 10. About seventy-five men interested in illumination were present. The report of the committee on constitution and nomination of officers appointed at the preliminary meeting was heard. The constitution was adopted. It designates the new organization as "The Illuminating Engineering Society," and states that its purposes are to advance the art of illumination and disseminate knowledge relating thereto. All persons interested in the objects for which the society has been formed are eligible to become members. The dues were fixed at $5 per annum, and during the first year there will be no initiation fee.

The following officers were elected: president, Lewis B. Marks; vice-presidents, Dr. Clayton H. Sharp and Mr. A. A. Pope; secretary, E. L. Elliott; treasurer, V. R. Lansingh. The board of managers consists of six members in addition to the officers. The members are: Dr. A. H. Elliott and Messrs. W. S. Kellogg, E. C. Brown, W. D. Weaver, F. N. Olcott and W. D'A. Ryan.

The secretary's office is at 25 Broad street, New York city. A resolution was adopted during the meeting to the effect that all whose applications for membership are received before the next meeting will be entered as charter members.

The next meeting will be held at the Hotel Astor, Tuesday evening, February 13, at 8.15 o'clock. At this meeting President Marks will make an address dealing with the relations of the new society to other organizations.

In addition to the seventy-five members present, letters have been received from about thirty others who wish to join the new society, so that it seems that it will have ample support.

American Society for the Advancement of Science.

The annual meeting of the American Society for the Advancement of Science was held in New Orleans, La., December 28 to January 3. The number in attendance was rather small, owing to the distance of the place of meeting from the centre of gravity of the society. The number of affiliated societies meeting with the general society was also small. The number of members registered at New Orleans was 233. The present membership of the association is about 4,500.

At the New Orleans meeting the plan of scattering the vice-presidential addresses throughout the week was tried, but it was found to be not entirely satisfactory.

The association decided to try holding two meetings a year. During the present year a meeting will be held in the summer at Ithaca, N. Y., and one next winter in New York city.

The meeting on Thursday, December 28, was devoted to executive work and to deciding on a programme for the remaining days. On Friday the first general meeting was held. This was called to order by the permanent secretary, Dr. L. O. Howard, who introduced the president-elect, Dr. Calvin M. Woodward. Dr. Woodward explained that, due to illness, President Farlow would be unable to be in attendance.

The association was welcomed to Louisiana, on behalf of the governor, by the Hon. Charles F. Buck, who spoke of the value to the city of such a meeting, and referred to the benefits which the South has already obtained from the scientific campaign against tropical diseases.

Mayor Martin Behrman welcomed the association to New Orleans, and pointed out the particular features of interest to visitors.

Dr. E. B. Craighead, president of Tulane University, welcomed the association to that institution.

President Woodward expressed the thanks of the association for the welcome extended.

In the afternoon meetings of the various sections were held, and addresses and papers listened to. Vice-President Ziwet addressed the section of mathematics and astronomy on "The Relation of Mechanics to Physics." Vice-President Kennicutt addressed the chemical section on "The Sanitary Value of a Water Analysis."

At 8 P. M. the address of the retiring president, Dr. W. G. Farlow, was given, the subject being "The Popular Conception of a Scientific Man of the Present Day."

On December 30 meetings of the various sections were held. Vice-President Magie addressed the physical section on "The Partition of Energy." Vice-President Knapp addressed the section of physiological and economic science on "Transportation and Combination." Dr. F. E. Venable, retiring president of the American Chemical Society, delivered an address entitled "Chemical Research in the United States."

On January 1 Vice-President Jacobus addressed the section of mechanical science and engineering on "Commercial Investigations and Tests in Connection with College Work." A number of the papers presented at the various meetings are not available for publication at the present time.

The following officers were elected for the Ithaca and New York meetings:

President—Dr. W. H. Welch, Baltimore, Md.

Vice-Presidents—Section A, Dr. Edward Kasner, New York city; section B, Professor W. C. Sabine, Cambridge, Mass.; section C, Mr. Clifford Richardson, New York city; section D, Mr. W. R. Warner, Cleveland, Ohio; section E, Professor A. C. Lane, Lansing, Mich.; section F, Professor E. G. Conklin, Philadelphia, Pa.; section G, Dr. D. T. MacDougall, Washington, D. C.; section H, Professor Hugo Münsterberg, Cambridge, Mass.; section I, Mr. Charles A. Conant, New York city; section K, Dr. Simon Flexner, New York city.

General Secretary—Dr. John F. Hayford, Washington, D. C.

Secretary of Council—President F. W. McNair, Houghton, Mich.

Annual Convention of the American Electrical Salesmen's Association.

The annual convention of the American Electrical Salesmen's Association will be held at the Grand Pacific Hotel, Chicago, Ill., Saturday, January 20.

New York Electrical Society.

The New York Electrical Society's "Franklin Night," for the celebration of the bi-centenary of Benjamin Franklin's birth, postponed from January 16 on account of Mr. Marconi's illness, will be given at the Edison auditorium, 44 West Twenty-seventh street, New York city, Wednesday, January 24. Addresses will be delivered by Dr. M. F. O'Reilly, on the electrical work of Franklin, and by Mr. R. R. Bowker, on Franklin as a statesman.

American Institute of Electrical Engineers.

The two hundredth and third meeting of the American Institute of Electrical Engineers will be held in the assembly room of the New York Edison Company, 44 West Twenty-seventh street, New York city, on Friday, January 26, 1906, at 8.15 P. M.

The following papers will be presented and discussed:

"Central Station Economics," by Henry G. Stott, superintendent of motive power, Interborough Rapid Transit Company.

"A Self-Exciting Alternator," by E. F. Alexanderson, electrical engineer, General Electric Company, Schenectady, N. Y.

The Railway Signal Association.

The January meeting of the Railway Signal Association was held at the Grand Union Hotel, New York city, Tuesday, January 9. The meeting was called to order by President C. H. Morrison, some sixty members being in attendance, and thirty new members were elected.

The change in the constitution proposed at the last meeting was voted upon and adopted, so that the association now has two vice-presidents, the newly elected officer being Mr. A. H. Rudd. A change in the by-laws was also adopted, as a result of which associate members will have only the privileges accorded to honorary members.

The reports of the following committees were heard: executive committee, on a digest of the proceedings of the association; committee on storage batteries, the report being presented by I. S. Raymer; committee on rubber-covered wires, reported by Azel Ames, Jr.

In the report on storage batteries Mr. Raymer called attention to the great value of these batteries for operating signals. The batteries are charged either by primary batteries or by power supplied from a generating station and are giving excellent service.

A paper was presented by G. K. Rodgers describing an improved Sykes block signal. A paper on the care of storage batteries was read by H. W. Lewis, in which the author gives directions for the care and charging of batteries. Mr. F. F. Fowle, of the American Telephone and Telegraph Company, read, by invitation, a paper on specifications for line wire.

Both the reports and papers were discussed vigorously and many interesting experiences were brought out.

New York Automobile Shows.

Two automobile shows were opened on Monday, January 13, in New York city. One of these, held at Madison Square Garden, was the sixth National Automobile Show. A large number of new cars were exhibited, especial attention being attracted by the new six-cylinder equipments.

The second exhibit was held by the Automobile Club of America at the Sixty-ninth Regiment Armory, Twenty-sixth street and Lexington avenue. Here also there was an excellent exhibit of cars, as well as balloons and airships of various types and other paraphernalia of that class.

The number of electrical cars exhibited was small, but there were several new and interesting types.

The Chicago Electrical Show.

The first annual exhibit of the Electrical Trades Exposition Company, of Chicago, Ill., was opened in the Coliseum in that city at eight minutes past eight o'clock Monday evening, January 15, by a wireless telegraph message from President Roosevelt. The message read: "congratulations and best wishes." The opening scene was one of remarkable brilliancy, as the lights, which had been dim, were suddenly thrown on and the machinery started. The attendance was large, consisting of over 8,000 interested spectators.

The exhibits are excellent and of great variety. The space utilized is over 30,000 square feet, and about 4,000 horse-power is supplied for power purposes and for lighting the building. It is said that no trade exhibit ever held in Chicago has represented so much money as does this electrical show.

The following is a list of exhibitors:

Ackerman-Boland Telephone Company, Allis-Chalmers Company, American Circular Loom Company, American Conduit Company, American De Forest Wireless Telegraph Company, American Electric Company, American Electric Fuse Company, American Novelty Company, American Steel and Wire Company, American Electric Sign Company, *American Telephone Journal,* Automatic Telephone Electric Company, Bryan-Marsh Company, Central Electric Company, Chicago Battery Company, H. B. Camp Company, Chicago Compound Battery Company, Chicago Edison Company, Chicago Pneumatic Tool Company, Chicago Telephone Company, Frank B. Cook, Crane Company, Crocker-Wheeler Company, W. P. Crockett & Company, W. L. Freed Company, Electric Appliance Company, Electrocraft Publishing Company, Electro-Dynamic Company, J. Lang Electric Company, S. J. Gorman & Company, Guarantee Electric Company, Edwards Headlight Company, *Engineering World,* Electric Storage Battery Company, Federal Electric Company, Fort Wayne Electric Works, North Shore Electric Company, General Storage Battery Company, D. Holcombe & Company, Safety Armorite Conduit Company, W. H. Schott, W. Schiedel Company, Simplex Electric Company, Stanley-G. I. Electric Manufacturing Company, G. H. Thordarson, Engineer Publishing Company, Universal Electric Storage Battery Company, Vesta Accumulator Company, Western Electric Company, Wagner Electric Manufacturing Company, Westinghouse Electric and Manufacturing Company, *Western Electrician,* General Electric Company, Haller Machine Company, H. T. Paiste Company, Krantz Manufacturing Company, Lincoln Electric Manufacturing Company, Monarch Electric and Wire Company, Miller Anchor Company, Mark Manufacturing Company, McFell Electric Company, Nungesser Electric Battery Company, Oliver Manufacturing Company, Overbaugh & Ayers Manufacturing Company, Osburn Flexible Conduit Company, Peabody Coal Company, Peru Electric Manufacturing Company, Porterberg-Peterson Manufacturing Company, John A. Roebling's Sons Company, Roth Brothers, Reynolds-Dull Flasher Company, J. L. Schureman & Company, Stromberg-Carlson Telephone Manufacturing Company, Swedish-American Telephone Company.

In addition to the above commercial firms, the following educational institutions have exhibits: University of Illinois, University of Wisconsin, Armour Institute, University of Colorado and Purdue University.

During the show entertainments of various kinds were given. Electrical novelties and tricks were exhibited in addition to demonstrations of more practical things. The two hundredth anniversary of the birth of Benjamin Franklin was celebrated and a number of conventions were held during the show.

Northwestern Electrical Association.

The fourteenth annual convention of the Northwestern Electrical Association was held at the Great Northern Hotel, Chicago, Ill., January 17 and 18. Addresses were delivered and papers read on Wednesday, and on Wednesday evening the members of the association attended the theatre. On Thursday evening a visit was made to the electrical show. No banquet was held. About 200 members were in attendance.

The Electrical Trades Association of Chicago.

The annual meeting and dinner of the Electrical Trades Association of Chicago will be held in the Coliseum annex, Chicago, Ill., on the evening of January 24. It is expected that this will be the largest meeting of credit men in the electrical trade that has ever taken place. During the dinner Mr. James Wolff, Chicago representative of the New York Insulated Wire Company, will act as toastmaster. Toasts will be delivered by representative manufacturers from all parts of the country.

The secretary of the association is Frederic P. Vose, Marquette Building, Chicago, Ill.

The Single-Phase Electric Locomotives and Power Equipment of the St. Clair Tunnel Company.

The single-phase electric locomotive adopted by the St. Clair Tunnel Company for the operation of the St. Clair tunnel, which connects the American and Canadian divisions of the Grand Trunk Railway system, will weigh approximately sixty-two tons and will develop a drawbar pull of 25,000 pounds on a two per cent grade at a speed of ten miles per hour. It is of the rigid frame type, with driving axle boxes held in the same frame that contains the draft gear. It will be mounted on three pairs of driving wheels which will sustain the entire weight, distributed by equalizer bars similar to those used in steam locomotive practice, will have an outside frame supported on semi-elliptical springs and will be equipped with Westinghouse friction draft gear, MCB automatic couplings, air sanding apparatus, and bumper steps, front and back. The cab will be of sheet steel mounted on a framework of iron which supports both walls and roof.

The principal dimensions will be approximately as follows:

Length over end sills, 27 feet 9 inches.

Rigid wheel base, 12 feet.

Width over all, 9 feet 6 inches.

Height from top of rail to top of cab, 12 feet 6 inches.

Diameter of driving wheels, 62 inches.

The operating apparatus will be arranged along the sides of the cab, leaving a free passage-way three and one-half feet wide the entire length. The cab will be lighted and heated by electricity, arrangement being made to screen the instrument lights while the locomotive is running.

Westinghouse combination automatic and straight air and American driver brakes will be used. The air supply will be provided by a two-cylinder motor-driven air compressor having, with a five-inch stroke and speed of 190 revolutions per minute, a capacity of forty-five cubic feet of air per minute. Air reservoirs, signal outfits, whistle, bell with pneumatic ringers, automatic pump governors, tools, instruments, gauges, headlights, push poles and other details complete the auxiliary equipment.

A motor will be geared to each axle, giving each unit an aggregated rated capacity of 750 horse-power. They are of the Westinghouse single-phase alternating-current, series-wound, compensating type, whose successful development was first publicly announced by Mr. B. G. Lamme before the American Institute of Electrical Engineers in New York, September 26, 1902. They are of the same general character as the motors selected by the New York, New Haven & Hartford Railroad Company for the operation of its line between New Haven and New York. Each motor will weigh complete approximately 14,500 pounds, the armature weighing approximately 5,600 pounds.

The motor frame consists of a steel cylinder cast in one piece and enclosed at the end by brackets of the same material, which carry the bearings and oil reservoirs. The suspension noses and safety lugs form a part of the main casting. Seats for the axle bearings are cast solid with the frame. All bearings are of phosphor-bronze lined with babbitt and are divided into two parts. They are of exceptionally large dimensions, are arranged for oil waste lubrication, and are provided with large openings on the low-pressure side, giving a thorough lubrication to the entire bearing surface. Oil is fed into the reservoirs through openings separate from the waste pockets and therefore reaches the waste from below and is thoroughly filtered before entering the bearing.

The motors are swung between the locomotive frame and the driving axles by a flexible nose suspension from two hangers supported by a truck transom and passing through heavy lugs with helical springs above and below the lug. The motors are held to the axle by means of caps, which are split at an angle of thirty-five degrees with the perpendicular, so that the greater part of the weight is borne by solid projections from the motor frame which extend over the axle rather than by the cap bolts. Large openings above and below provide access to the commutator and brush holders.

Within the cylinder of the motor frame there is built up a core of soft steel punchings, forming a complete laminated field. The punchings are dovetailed into the frame and clamped between end rings of cast steel. The field coils are wound with copper strap insulated between turns and about the coils by mica and finished by taping and dipping, and are impregnated in the best grade of varnishes, providing a sealed coil which can withstand the most severe internal heat and is practically indestructible under the usual conditions of heavy railway service.

In addition to the main coils, the field carries a neutralizing winding which consists of copper bars placed in slots in the pole-faces and joined at the ends by connectors of copper strap, so as to form one continuous winding which is connected in series with the main field winding and with the armature circuit. The magnetizing effect of this auxiliary winding is directly opposite to and neutralizes that of the armature winding, thus eliminating the effect of armature reaction and improving commutation and power-factor. The main coils can be easily removed without disturbing the auxiliary winding.

The armature cores are formed of slotted soft steel punchings built up upon a spider and keyed in place. The spider is forced upon the shaft with heavy pressure and secured by a steel key. Coils of copper strap are embedded in the slots and joined to form a closed multi-circuit winding which is cross-connected like the multi-circuit winding of a direct-current generator. The basis of the insulation is mica. A preventive winding is connected between the commutator and the main coils, introducing a preventive action which is effective only when the coil is passing under the brush.

During operation a forced circulation of air supplied by motor-driven blowers enters at the rear, distributes itself thoroughly throughout the motor and escapes through the perforated cover over the commutator. This system of forced ventilation of both motors and auxiliary apparatus forms one of the most interesting innovations in electric railway construction. It secures a maximum output from a given weight of material and a high ratio of continuous output to the one-hour motor rating common in railway practice. It also provides effective ventilation while the locomotive is not in operation, as the blower may be driven while the locomotive is standing at the station or at the end of the line. Motors ventilated in this manner are enclosed and are thereby protected from internal damage by dirt and water and from mechanical injury.

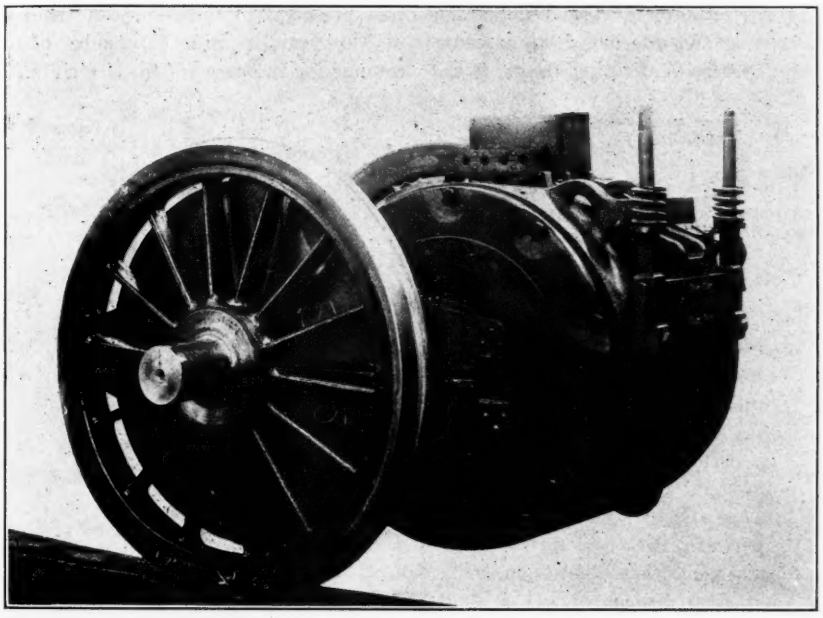
These motors are wound for 240 volts, twenty-five cycles per second, and have a nominal rating of 250 horse-power each, on the basis of usual electric railway practice.

SYSTEMS OF CONTROL.

The essential elements of the control equipment include the collecting devices, the autotransformers, the unit switches, the preventive coils, the reverser and master controllers. A multi-unit system of control is provided with pneumatically operated switches and circuit-breakers, low-voltage control circuit, and other characteristics standard in Westinghouse practice. Any unit may be controlled from either end, and two or more units may be coupled together and operated from a single cab and by a single crew. The tractive effort which can be readily

applied to a single train is therefore limited only by the number of units available and the hauling power is limited only by the mechanical strength of the coupling between locomotive and cars. A control circuit is carried from one unit to the next by means of connecting sockets and jumpers in the usual manner.

Speed control of the driving motors is secured by variation of the voltage at the motors obtained by means of taps taken from the winding of the autotransformer which receives current from the trolley at 3,000 volts and reduces it to 240 volts or lower, according to the tap employed. These taps are connected to unit switches from which current is led through the preventive coils to the motors. Four unit switches serve to reverse the field of each motor.



250 HORSE-POWER, SINGLE-PHASE RAILWAY MOTOR MOUNTED ON AXLE AND DRIVING WHEEL.

The unit switches are of standard Westinghouse design and are, in effect, pneumatically operated circuit-breakers of great power and reliability. The mechanism is such that a rolling and sliding contact is obtained when the switch closes and opens. The arc is broken at the tips, leaving the contact surfaces smooth and unscarred. Each unit has a magnetic blow-out coil with laminated core. The switch cylinders are controlled by magnetically operated valves, current for which is obtained from a fifty-volt tap from the autotransformer. The sequence of operation is governed by the master controller in conjunction with a system of interlocks which prevents short circuit of the steps between taps from the autotransformer or improper operation of the controlling mechanism. At any running point four controlling switches are closed. Through the preventive coils approximately the same amount of current is drawn from each of these switches and the leads to which they are connected. To change to a higher voltage on the motors the master controller is moved to the next notch, opening the last switch of the group that is closed and closing the switch next higher, with the result that the motor voltage is shifted up one step. By this arrangement the voltage at the motor will be completely under control of the locomotive driver and may be varied up and down at will without opening more than one-quarter of the load current. Small switches in the circuits to the magnets of the reversing switches will enable any motor or combination of motors to be cut out without disturbing the others.

Every one of the seventeen controlling connections provides an efficient running point. This number is ample to prevent any slipping of the driving wheels due to increase of current from one notch to another. Whether empty or heavily loaded, operated in single or multiple units, torque and draw-bar pull may be gradually applied and the locomotive started without jar.

COLLECTING DEVICES AND OVERHEAD CONSTRUCTION.

Each locomotive unit will be equipped with a pneumatically operated pantagraph trolley to collect current from the overhead lines outside the tunnel and throughout the yards. The proportions of the pantagraph will be such that when extended it will make contact with the trolley wire twenty-two feet above the rail, and when closed down the contact shoe will not extend more than eighteen inches above the roof of the locomotive. The pantagraph will have a broad base and will be constructed of light and stiff material.

A No. 000 grooved overhead trolley wire will be suspended from a single five-eighth-inch, high-strength, double galvanized, steel strand, messenger cable by hangers of varying length in such a manner that the trolley wire will be approximately horizontal. The messenger cable will be swung from structural iron bridges located throughout the yards and are of suitable length to span the proper number of tracks. There will also be a small section of track equipped with a trolley line swung by catenary suspension from bracket arms which are supported on lattice-work poles.

CURRENT SUPPLY.

For the operation of the electric locomotives a complete power plant will be installed by the St. Clair Tunnel Company, including two 1,250-kilowatt, 3,300-volt, three-phase, twenty-five-cycle, 1,500-revolutions-per-minute, rotating field, Westinghouse steam-turbine units, with the necessary complement of switchboards, exciters, lightning protective apparatus, etc. This station will also supply current to light the buildings, yards and tunnel, to operate motor-driven centrifugal and triplex pumps which drain the tunnel and approaches and operate the sewage system, to run motors in the round-houses and for other purposes.

OPERATION.

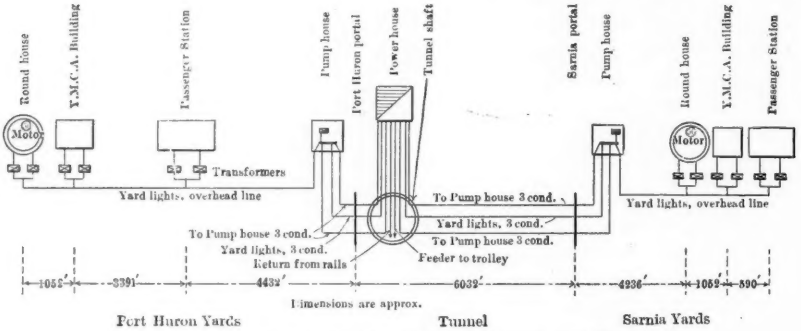
The new equipment will handle that portion of the Grand Trunk Railway system which connects the divisions terminating at Port Huron, Mich., and Sarnia, Ont., on opposite sides of the St. Clair river. The tunnel proper is 6,032 feet long and the line to be electrically operated measures 19,348 feet from terminal to terminal.

A pair of the new units will be capable of hauling a 1,000-ton train through the tunnel without division. Mechanical considerations limit the advisable weight of train in the tunnel to these figures. Heavier trains can be divided or sent through, together with locomotives in front and behind. The service requires that each unit shall take a train of 500 tons through the tunnel block from sum-

mit to summit in fifteen minutes, under the following conditions:

It will be coupled to the train on a level track at a point 1,200 feet from the summit and must accelerate it up to a speed of twelve miles per hour in two minutes, at the end of which time it will have reached the summit of the grade leading down into the tunnel. It will then run down a grade of two per cent to the level track in the tunnel at a speed not exceeding twenty-five miles per hour, continue on the practically level stretch under the river, and then draw the train up a two per cent grade at the rate of ten miles per hour to the level track beyond the tunnel approach on the other side. It must then gradually accelerate the train until a speed of eighteen miles per hour is reached. Each unit must be capable of exerting a tractive effort of 25,000 pounds for a period of five minutes in addition to the energy required to accelerate the train at the starting point and to run with it into the terminal yard, from which point it must immediately run back to a position of 1,200 feet from the summit, couple to another train and be ready to start through the tunnel in the opposite direction. It must therefore make a run of the character described every thirty minutes.

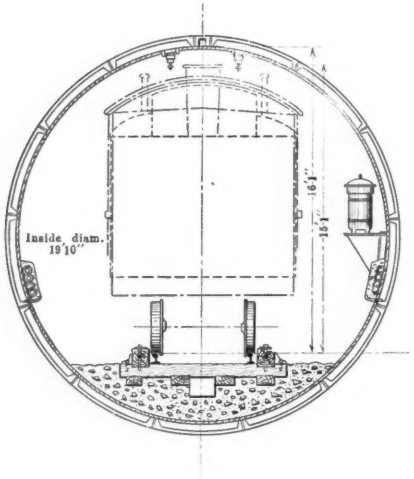
Six of these locomotives are to be furnished by the Westinghouse company.



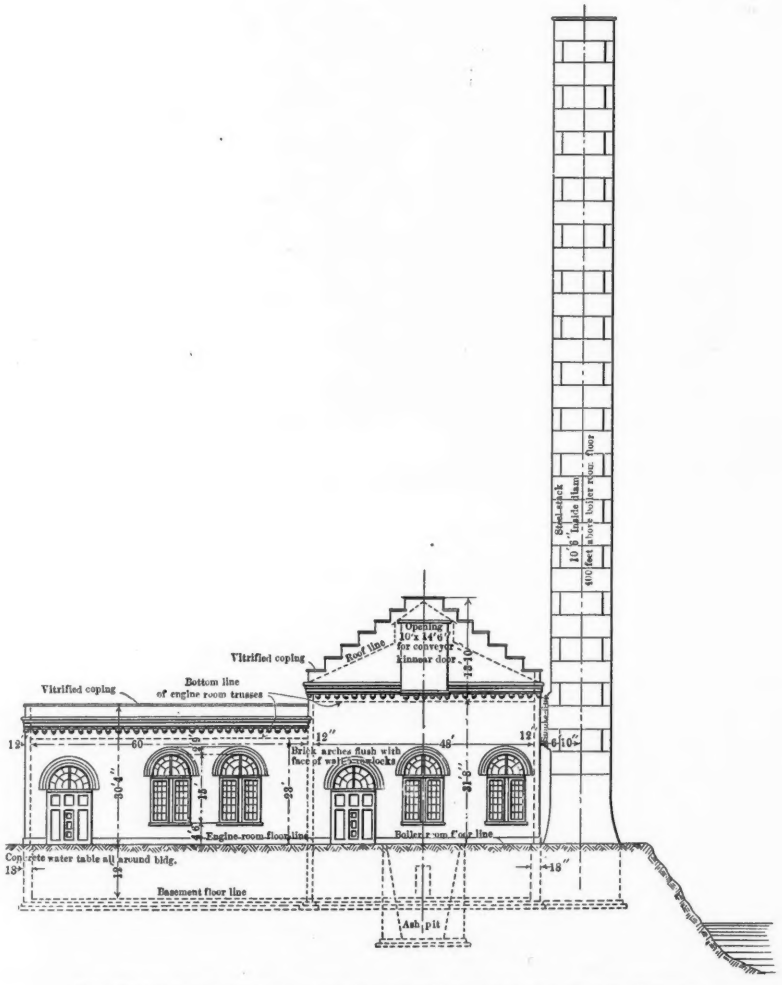
FEEDER SYSTEM, SARNIA-PORT HURON YARDS AND TUNNEL.

It is expected that the electric equipment will greatly relieve the traffic congestion now existing and due in a large measure to the necessity of dividing trains at the terminal points and to greatly simplify the operation of the road. Its opening will mark the progress of electrical methods in the railway field under conditions which seem peculiarly fitted to demonstrate its practical advantages in heavy service. That the single-phase system has been adopted for so important an undertaking makes evident the recognition accorded the alternating current by railway engineers and indicates that its claims have been verified by the service already rendered.

The work of installation will be conducted under the supervision of Mr. Bion J. Arnold, of Chicago, consulting engineer for the tunnel company, by whom the plans and specifications were prepared. Mr. Arnold was one of the first engineers in America to advocate the employment of the single-phase, alternating-current system in railway service. He is also a past president of the American Institute of Electrical Engineers, a member of the commission in charge of the electrification of the New York Central Railroad system in New York and has been closely identified with many electrical developments of great importance.



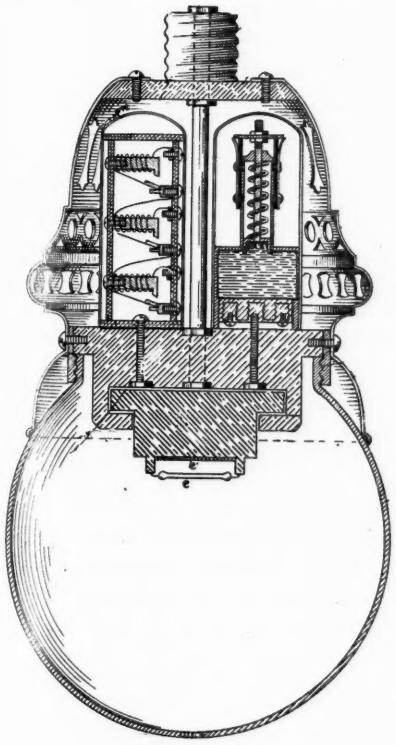
SECTION OF ST. CLAIR TUNNEL.


Vitrified coping
Roof line
Opening 10'x14'6" for conveyor & inner door
Vitrified coping
Bottom line of engine room trusses
Brick arches flush with face of wall & voussoirs
Engine-room floor line
Boiler-room floor line
Concrete water table all around bldg.
Basement floor line
Ash pit
Steel stack
10'9" inside diam.
410 feet above boiler plan floor

END ELEVATION OF PROPOSED POWER PLANT FOR ST. CLAIR TUNNEL.

Electrical Patents.

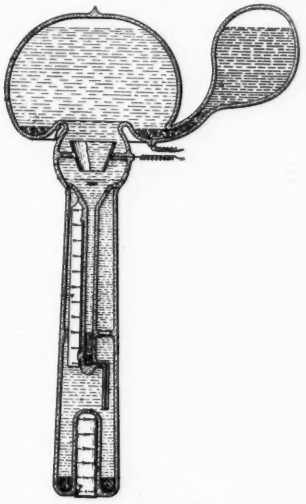
An improvement in an electric glow lamp has been invented by Gustave K. Hartung, of New York, N. Y. (808,085, dated December 26, 1905.) This invention in electric lamps relates to that class known as "glow lamps," wherein the light-giving element or "glower," as it is technically termed, is a conductor of the second order. The object of this invention is to provide a durable lamp and also to increase the life of the glowers. This is accomplished by providing a plurality of reserved glowers which may be rendered serviceable upon the disruption or the termination of the life of an active one, and in this connection the invention is



GLOW LAMP.

directed toward the control of the glowers and the devices for automatically throwing them into circuit with the source of energy as demanded by the conditions aforesaid, thus limiting the life of the lamps to the number of reserved glowers provided. In an electrical glow lamp having a plurality of light-giving elements of secondary conductivity having independent controlled circuits and suitable electrical circuits and controlling devices for the light-giving elements and a suitable ballasting resistance therefor, a common heater for the secondary light-giving element comprising a support and a sinuous metallic filament formed thereon and carried thereby, electrical circuits and terminal connections for the heater and a thermostatic controller therefor actuated by a ballasting resistance for throwing the heater into and out of circuit as the secondary conductors mature according to the maturity or relaxation thereof.

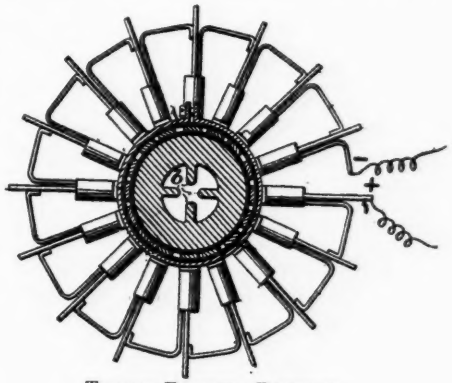
Alvarado L. R. Ellis, of Lynn, Mass., has obtained letters patent of the United States (808,232, December 26, 1905) for an improved electrolytic meter, and he has assigned the same to the General Electric



ELECTROLYTIC METER.

Company, a corporation of New York. This invention relates to electric meters, and particularly to meters of the electrolytic type. Its objects are to effect certain improvements in the construction of meters of this type whereby they are made more compact and less liable to breakage, and to provide what has been termed a "second dial" effect; that is, two or more scales so related that the registration is transferred from one scale to another and the full registration on one scale at the time of the transfer to the next higher scale produces a definite registration on the higher scale. An electrolytic mercury meter having an anode chamber, mercury therein, a cathode, a graduated receptacle below the cathode for collecting the electrodeposited mercury in a single column, a second graduated receptacle, and means dependent upon the height of said column for permitting the flow of the mercury constituting the column into the second receptacle.

Albrecht Heil, of Frankfort-on-the-Main, Germany, has obtained letters-patent (808,086, December 26, 1905) for an improved thermo-electric battery, and he has assigned this to the firm of A. Wolf, Jr., Company, of Frankfort-on-the Main, Germany. The invention relates to improvements in thermo-electric batteries in which a central vertical and hollow-heating shaft or flue is provided on the external surface with a plurality of insulated radial thermo-electric couples; and the objects of the improvements are first, to provide the external surface of the central veritcal and hollow-shaft or flue with a layer of insulating material; second, to provide on this layer of insulating material a plurality of heating-plates, which are mostly in contact with the insulating layer and for the rest bent to project outward, preferably horizontally; third, to provide a plurality of thermo-electric couples whose warm ends are united with the projecting ends of the heating-plates in as narrow or small contact-faces as possible, and fourth, to provide a plurality of radial and vertical cooling-plates which are each united with the external ends of the positive components of a thermo-electric couple and with the external end of the negative component of a neighboring thermo-electric couple. The invention consists in the combination with a vertical flue provided internally with a plurality of longitudinal radial heating-ribs and externally with a layer of insulating material, of means for heating the vertical flue externally, a plurality of heating-plates on the insulating layer of the vertical flue and having



THERMO-ELECTRIC BATTERY.

each an end projecting outward, a plurality of radially disposed thermo-electric couples comprising each a positive rod-shaped component and a negative wire-shaped component whose warm ends are united with the projecting end of one of the plurality of heating-plates in narrow or small contact-faces, and a plurality of radial cooling metallic-plates secured on the external ends of the positive components of this plurality of thermo-electric couples and united each with the bent external end of the negative component of a neighboring couple, so that the several couples are connected and the cooling-plate of the first couple may be connected with the one line and the negative component of the last couple with the other line of the circuit.

Reviews of Current Engineering and Scientific Literature.

Magnetic Ignition of Gas Engines.

There are two general classes of ignition devices employed for firing gas engines. One of these may be called the interrupter type and the other the arc. In the first a fairly heavy current is established through an inductive circuit, and by means of a make-and-break device operated by the engine the circuit is broken at the proper moment. The advantages of this type are the low voltage employed and the heavy spark produced. The system may also make use of a magneto, thus doing away with the troublesome battery. In the other system a battery is employed to operate an induction coil which sets up a series of sparks at the proper moment within the engine cylinder. This latter device is very sure in its action, but, as generally employed, necessitates the use of primary batteries. In the system here described it is attempted to combine these two systems, utilizing the advantages of each and doing away with the disadvantages. It consists in employing a magneto driven by the cam shafts of the engine. This produces an alternating current, which is transformed up in a suitable transformer so as to produce a series of sparks in a cylinder. The system is due to M. Caint-Romain and is said to give much satisfaction. It is claimed for it that the construction of the apparatus is simple and strong and the speed is low. As the voltage generated in the magneto is low there is no difficulty in insulating the coils. The method of transforming up to produce the igniting sparks does away with high-tension contacts, and the current produced, as well as the voltage generated, are constant, thus giving surety of operation.—*Translated and abstracted from L'Electricien (Paris), December 23.*

The Distribution of Electricity on Board War Vessels.

In this section of a serial upon the applications of electricity on board ships of war, M. P. Kergarouët considers the important questions of the choice of voltage and the running mains. Until recently the prevailing voltage was eighty, this being selected in order to suit the searchlights, which were at one time thought to be the most important electrical devices employed on ships of war. The more general use of incandescent lights and of motors has made it necessary to reconsider this decision. While eighty volts suits the searchlights, 110 volts is better adapted to incandescent lighting. This is even better than 220 volts, which would be more suitable for motors. The three-wire system is, unfortunately, too complicated for men-of-war, where there must be, in addition to great simplicity, a duplicate set of mains. It is decided that 120 volts more nearly suits all the conditions met and it is thought that this will become the standard in the future. The methods of running conductors have been revised since the last two naval wars. Up to that time it was customary to carry the wires in wooden ducts or conduits—a system very satisfactory so far as regards the normal operation of the plant, but recent experience has made it necessary to do away with all wood in the fighting quarters. It therefore becomes necessary to employ armored cables. The conductors are generally covered with rubber, over which is a lead sheathing. This is then insulated and protected by a double layer of steel tape, which is in turn insulated. Cables made in this way are simply attached to the walls or ceilings of the vessel. This system of wiring gains greatly with the use of the higher voltage, since with eighty volts only the cross-section of the conductors was great and it was difficult to handle and install them. To provide two independent systems of supply duplicate mains should be run along the two sides of the vessel. An injury on one side will generally leave the other side available for use. Switches must be arranged at all important pieces of apparatus, enabling them to draw their supply from either system of mains.—*Translated and abstracted from L'Éclairage Électrique (Paris), December 16.*

The Zambesi Power Scheme.

Mr. Robert Hammond here criticizes the proposed development of Victoria falls on the Zambesi river for distributing power to the mines on the Rand, 700 miles distant. Mr. Hammond proposed, some time during the past summer, that large steam plants be erected at the mines for supplying electrical power to the surrounding country, and he thinks that the figure given by Mr. W. B. Esson of 1.10 cents per kilowatt-hour for the working costs would be entirely too high for any commercial success. The one great economy with which water power can be credited, which overshadows all other small subsidiary economies, is the saving of the coal bill. If the capital charges, maintenance and renewals, cost of transmission line and the cost of the energy lost in transmission involved by the use of water power are much greater than the coal bill of a steam plant at the delivery end of the transmission line, then, obviously, the use of water power can not be justified. Coal having a calorific value of 11,000 British thermal units per pound can be delivered into the bunkers of the steam stations for about $1.20 per short ton. The same coal can be delivered anywhere on the Rand itself for $2.50 per ton. It is therefore unnecessary, in considering this question, to take up the transmission of the energy over a short distance in order to demonstrate the advantages of the cheaper fuel. It is sufficient for the present comparison to construct a steam plant situated at a central point on the Rand. The annual coal bill of such a station having an output of 85,500,000 kilowatt-hours, with coal at $2.50 per ton, and allowing a consumption of four pounds of coal per kilowatt-hour, would amount to about $460,000 per year. As against this figure must be put Mr. Esson's estimate of $1,000,000 per year as the capital cost and maintenance costs alone involved by a transmission line from the falls. The steam plant, therefore, has $500,000 to its credit with which to meet the small additional economies which might result from the use of water power, such as a saving in boiler house, wages, waste, oil, etc. Mr. Esson estimates the power could be sold for 1.5 cents per kilowatt-hour, though he shows that the interest on capital, maintenance and renewals alone would amount to 1.36 cents per kilowatt-hour, delivered and transformed at a central spot on the Rand. He therefore allows himself only 0.14 cent per kilowatt-hour to cover interest on capital, maintenance and renewals on distribution lines which would have to supply the mines scattered over an area about fifty miles long by ten miles wide, and the cost of wages for both the generating and transformer stations in a country where a mechanic gets $5 a day and other wages are on the same scale. Further, this item of 0.14 cent must also cover administration charges and interest on working capital. The conclusion, Mr. Hammond thinks, is obvious.—*Abstracted from the Electrical Review (London), December 22.*

The Future of Electricity in Paris.

Early last spring a report was made by a special commission dealing with the problem of systematizing the electrical supply of Paris. At the present time this is carried out by a number of private companies, each having its own system and each covering, more or less, a section of the city. The report recommended that the city be divided into three sections, each to be supplied from a large modern generating station located on the Seine. To meet the many requirements for light and power it was recommended that a three-phase, high-tension system of transmitting power at fifty cycles, 12,000 volts, to various substations be adopted. In the centre of the city rotary converter substations were to be employed for distributing direct current to secondary mains. For the outlying districts alternating current was to be used, in order to avoid the expense of substations. It was the latter requirement that led to the recommendation of fifty cycles, rather than twenty-five cycles, which would be more suitable for power purposes and for rotary substations. The plan proposed has not received much encouragement, and recently the question has been reopened by the submission of four bids by independent companies to the city of Paris. In this article M. J. Blondin reviews the situation and considers the four proposals. Three of these companies offer to supply one section of the city only, the fourth proposes a system for supplying the entire city. In one proposition electrical energy is to be transmitted from a main generating station to substations and from these distributed as direct current. This company proposes a maximum charge of twelve cents per kilowatt-hour for lighting, and five cents for power. The company is to turn over its entire system to the city in 1942, or the city will have the right to purchase the plant in 1922. The second company offers to supply electrical power to that part of the city lying on the left bank of the river at a maximum rate of twenty cents per kilowatt-hour. The concession is to run for thirty-five years, beginning January, 1911. When the income exceeds $150,000 the city is to share in the profits. The third proposition is also limited to the city line on the left bank of the river. The plant is to be turned over to the city in 1942, or the city may purchase the property at the end of 1922. The fourth proposition is the more general one, and covers the entire city. This plan calls for a monopoly of the electrical supply, except as regards the traction systems, which have already their own generating stations. The contract can be terminated at the end of 1923, 1928 or 1933, as the city desires. It agrees to turn over to the city eight per cent of the receipts from the sale of current, and forty-five per cent of the annual profits. The total income to the city from this proposition would be about $800,000. By adopting the latter proposal or two of the other proposals, the city would be able to tide over the period until it is in entire control of its electrical supply. It would, however, have to decide upon a general plan in order that the entire work might be coordinated. It is suggested that a frequency of 41.66 would be a satisfactory compromise, as this would be satisfactory for lighting purposes in the suburbs, and well suited to the operation of rotary converter stations for the centre of the city.—*Translated and abstracted from La Revue Électrique (Paris), December 15.*

The Plant of the Vancouver Power Company.

Vancouver, British Columbia, is a city of about 40,000 inhabitants. It has had an electric light and street car service, the power for which has been supplied from a steam plant. This plant had grown with the electrical systems until it included many units of different types and sizes. Although good steam coal can be mined within sixty miles of Vancouver, for commercial reasons this can not be obtained at a reasonable rate, hence the electrical interests have sought for water power to enable them to construct a plant from which power could be supplied at a low cost. The site selected is at lake Coquitlam, about sixteen miles from the city of Vancouver. In this section of an article describing the installation, Mr. William Meredith gives details of the hydraulic works. The developments consist of a dam at the outlet of the lake so as to create a storage area; a tunnel connecting this lake with Trout lake, which serves as a water conduit; a dam across the outlet of Trout lake, and a pipe line from this dam to the power station, situated on a navigable arm of the sea just above high tide. The main source of supply is Coquitlam lake, which has an area of 2,300 acres at an elevation of 432 feet above sea level. The drainage area is approximately 100 square miles and the annual precipitation is about 150 inches. Measurements of the flow, taken at the outlet of the lake, over a period of thirteen years, show that the lowest stage of water ever recorded occurred in September, 1904, when the flow was 300 cubic feet per second for a period of nearly fifteen days. The flow gradually increased until on November 30 it was 5,000 cubic feet per second. Trout lake, which serves as a balancing reservoir at the head of the pipe lines, is separated from Coquitlam by a mountain range rising 4,000 feet above the surface of the lake. The horizontal distance between the two nearest points of the lakes is 12,775 feet—nearly two and one-half miles. The area of Trout lake is about 500 acres and its elevation above the sea 400 feet. The difference in elevation between the two lakes is therefore thirty-two feet. The tunnels run from the portal at Trout lake with a rising grade of 0.14 per cent for 6,300 feet and thence with a decline of 0.02 per cent for 5,600 feet to the drainage sump, where the pumping plant was located. The normal sectional area of the tunnel is seventy-five square feet, the section being nine by nine feet, with rounded corners. For the control of the flow of water through the tunnel two gates are provided in the main tunnel at a distance of sixty feet from the Coquitlam portal. The dam at the outlet of Coquitlam lake is a rock-filled, timber-crib structure. The dam across the outlet of Trout lake is located at a point where the creek passes through a deep ravine, about half a mile from the outer end of the lake. The top of the dam is built up to the level of Trout lake. It has a length of 361 feet and a maximum height of fifty-four feet. There are ten fifty-four-inch steel pipes and two twenty-four-inch pipes penetrating the dam at a point twenty-two feet below its top. These pipes are fitted with special roller gate valves at the face of the dam with separate screens for each pipe. The sixty acres of land lying between the dam and the lower end of Trout lake have been added to the lake. The pipe line extends from the dam to the power-house at sea level, a total length of 1,800 feet. A proportion of each line is of wooden-stave construction fifty-four inches in diameter and extends from the dam for a distance of 800 feet to a point where it is under pressure due to seventy-five feet head. From this point to the power station the pipe lines are riveted steel, varying in thickness from nine-thirty-seconds of an inch to seventeen-thirty-seconds of an inch, and ranging in diameter from forty-eight inches to forty-two inches at the lower end.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), January.*

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

The Portland General Electric Company, Portland, Ore., made use of a full page in the Friday issue of the daily papers for several weeks preceding Christmas. This full page was in colors, and set forth the multifold advantages of electricity. In one corner was a reproduction of a brilliantly illuminated street, on the other the illumination of a country house with a wood background. In a lower corner the utilization of the electric laundry iron was displayed, and in another corner was a presentation of the delights of the electric chafing-dish. More and more is it becoming evident that the public is interested in electricity for domestic consumption. Such advertisements as this simply strengthen the faith that the prospective customer has in the new utility, and it is to be hoped that very soon the electric fixture will become just as familiar in every home as the gas fixture is to-day. No builder at the present time would consider the erection of a structure, of no matter what dimensions, and not include the necessary gas piping. The gas is no safer than electricity, and in many ways is highly dangerous. It would be well for all solicitors of electric companies to make themselves acquainted with every disadvantage that gas or other forms of illumination possess, and keep these before prospective customers to such a degree as will warrant a wholesale conversion to the use of electricity.

An interesting article discussing the management of small central stations from an English standpoint was contributed to the *Electrical Review* (London) recently by Mr. Henry Joseph. The efforts made by the central stations to increase their load may be carried too far, Mr. Joseph believes, especially when the station under consideration is a small one. He takes issue with a number of the practices which have come more or less into use, holding that frequently they are unprofitable and unwise. While in a large plant it is desirable to spread out the load as much as possible, this does not necessarily follow in a small plant. It is quite a debatable point whether it is advisable for such a plant to encourage day load at all, especially if, in order to do so, the rates for such purposes are to be materially reduced. In a plant in a small town having less than 10,000 inhabitants it is very unlikely that the day load will for years be sufficient to load the smallest generating set economically, consequently the current used in the daytime must be supplied from a battery; but batteries are expensive to install and to keep up, and, besides, they entail an additional energy loss due to the conversion and reconversion of energy. In small towns, where no appreciable day load is anticipated, it may be advisable to install a small oil or gas-driven set in place of the battery.

The maximum-demand system has been adopted to a considerable extent in England. The theory of this system is that by its use the central station will be able to flatten out the peak of its load, and at the same time the consumers will be charged in proportion to the cost of supplying them. The system, while no doubt perfect in theory, may involve an amount of work out of all proportion to the advantage resulting from its adoption.

The system of charging at a reduced rate for heating and power purposes, irrespective of the hour at which the demand is made, seems also to be unsound to Mr. Joseph. This condition is being met by the use of double tariff meters controlled by time switches. The system seems sound in theory, but it remains to be proved whether the extra capital cost is justified by the advantages gained. One of these advantages is the tendency to prevent the overlapping of the lighting and power loads. If this were its only merit the system would certainly not pay for itself; but it also has one great point in its favor: if the cheaper rate be sufficiently low, the consumer can very well afford to be extravagant in his daylight consumption and will not hesitate to make what use he can of his supply as long as the meter is only registering cheap units; hence it encourages the use of apparatus which otherwise would not be used at all; and, what most of all is needed in a station of moderate size, it results in a long-hour day load.

In most small towns in England a great deal of attention is given to the prepayment system. It is usual to wire small houses up to ten or twelve lights free of charge, the slot meter being arranged so as to charge the consumer about twenty-five per cent more than the ordinary rate in lieu of paying for the hire of the meter and installation. This system has in many places been fairly successful, but things have to be cut very fine to make it pay, and the cost of the meter is often nearly as large as that of the installation. Most prepayment meters are liable to get out of order through careless use or bent coins or some inherent defect. If all the costs incurred in connection with the prepayment system were properly allocated, very few towns would, in the opinion of Mr. Joseph, show much of a margin on this class of consumer. One of the advantages of the prepayment system is that the clerical costs are reduced to a minimum, and if special efforts were made to lower the capital charges, there is no reason why there should not be a considerable profit on such consumers.

It should be borne in mind that consumers show sheeplike tendencies, and when once a start has been made in a particular district it is a comparatively easy matter to add other consumers. Three consumers, each paying $50 a year for current, are better than one consumer paying $100. For this reason it is best to arrange the installation so as to reduce, as far as possible, the current consumption of every consumer. It is only by so doing that the gas companies can be successfully competed with; therefore current-saving lamps should be advocated and care taken that high-power lamps be not installed where a lower-power lamp will be sufficient. Where an excessive amount of illumination is provided it is not appreciated, but the correspondingly increased cost for current is a cause for complaint. Complaints should not be treated lightly, but a responsible person should be detailed to enquire into them.

Mr. Joseph lays emphasis upon the necessity for keeping all capital costs as low as possible on small systems. Large systems can afford to adopt extravagant means to safeguard their supply and maintain a steady pressure, but in a small undertaking it is necessary to do everything in the cheapest manner consistent with economy and sound engineering.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Automatic High-Speed, High-Economy Engines.

The Harrisburg Foundry and Machine Works, Harrisburg, Pa., has paid particular attention to the development of an engine which would have a higher economy and improved steam distribution than the Corliss rotating valve design, and at the same time operate at higher rotative speeds than ordinarily reached in Corliss engines or the rotating valve type and to decrease floor space, generator cost, foundation and attendance.

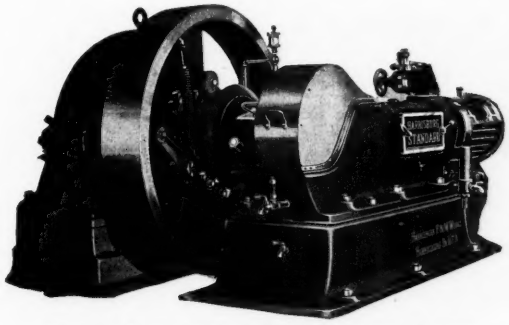


FIG. 1.—FLEMING SIDE-CRANK ENGINE, DIRECT-CONNECTED STYLE.

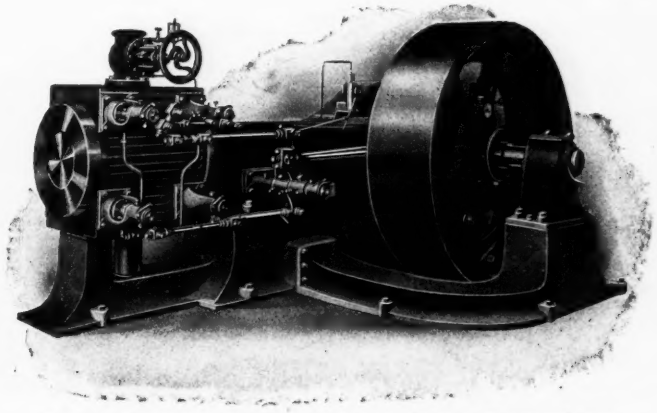


FIG. 2.—FLEMING SIMPLE FOUR-VALVE ENGINE, BELTED STYLE.

The Fleming automatic high-speed, single-valve engine shown in Fig. 1 represents a progressive step toward an economical engine of this type. As an indication of advancement along this line of high economy in flywheel governing engine design, tests made of an engine of this type at 270 revolutions gave results, the company claims, higher than the average of eighteen authentic tests of Corliss engines running at characteristic speeds, measured in net efficiencies. At light loads the increased efficiency is marked. One solution of the problem of designing a high-speed engine is the Fleming four-valve engine, built by the Harrisburg Foundry and Machine Works. In the earlier stages of development the engines were built with the wrist-plate style of gearing, but after several thousand horse-power had been in service for a number of years it was decided that this style of construction was not the best and was deficient in those qualities of durability and noiseless operation, as well as in other points essential to a perfect machine. Profiting by experience and careful study of the details, the defects of the first engines were remedied, and an

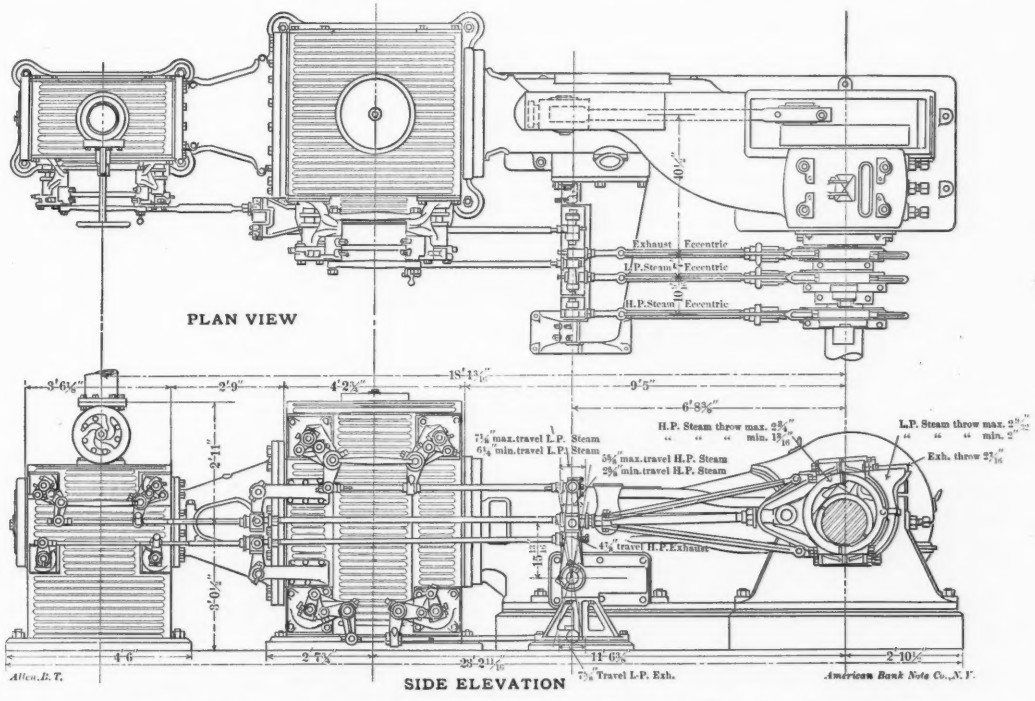


FIG. 3.—SECTIONAL DRAWING OF FLEMING TANDEM-COMPOUND FOUR-VALVE ENGINE.

engine finally produced which, after years of service, appears to meet the requirements in every way.

The single-cylinder style of this engine is shown in Fig. 2. This is a Fleming simple four-valve engine, belted style. This engine, however, is built for direct-connected units from 100 to 2,000-horse-power capacity. The engine is constructed with four rotating valves of an improved Corliss type, operated directly by a centrally balanced centrifugal inertia governor placed in the flywheel on the engine shaft and without the use of wrist-plates or auxiliary cutoff device. The steam valves are semi-balanced and triple-ported, and operate in chilled cast-iron bushings or cages, which can be readily removed in cases where repairs are necessary.

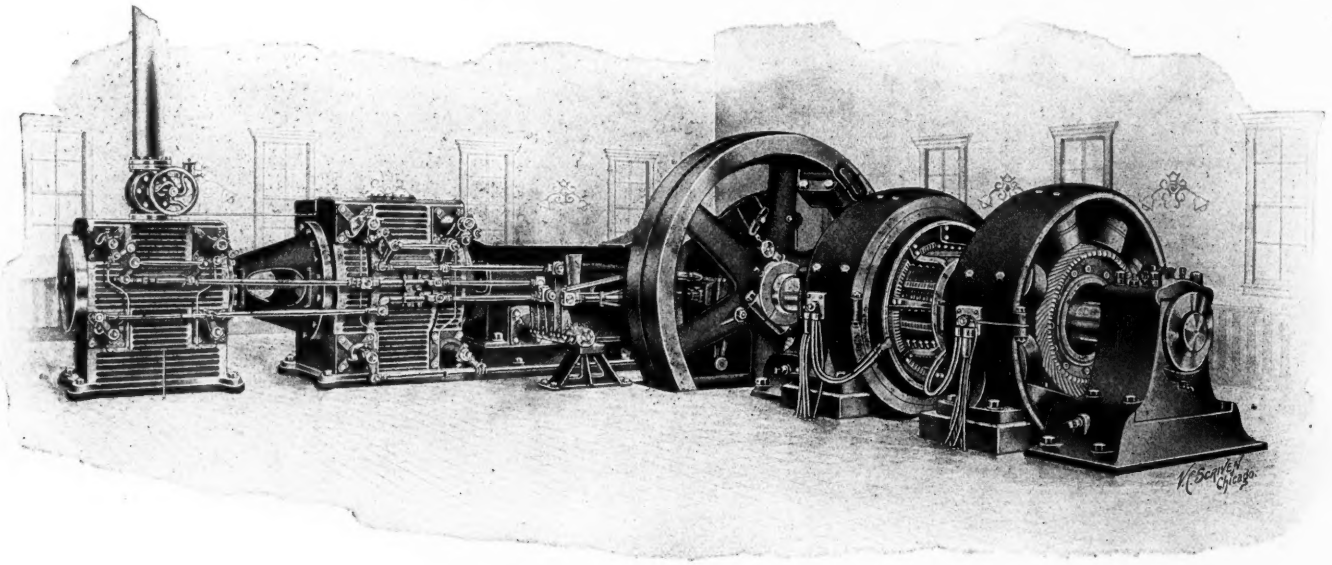


FIG. 4.—FLEMING TANDEM-COMPOUND FOUR-VALVE ENGINE FOR DIRECT-CONNECTION TO TWO GENERATORS

The exhaust valves are usually single-ported on the smaller sizes and double-ported on the larger engines. The construction is such that the pressure exerted is just enough to hold them to their seats to avoid leakage and yet enable them to operate smoothly at high rates of speed without friction. The steam valves are actuated by bell cranks operating on pins attached directly to the valve brackets

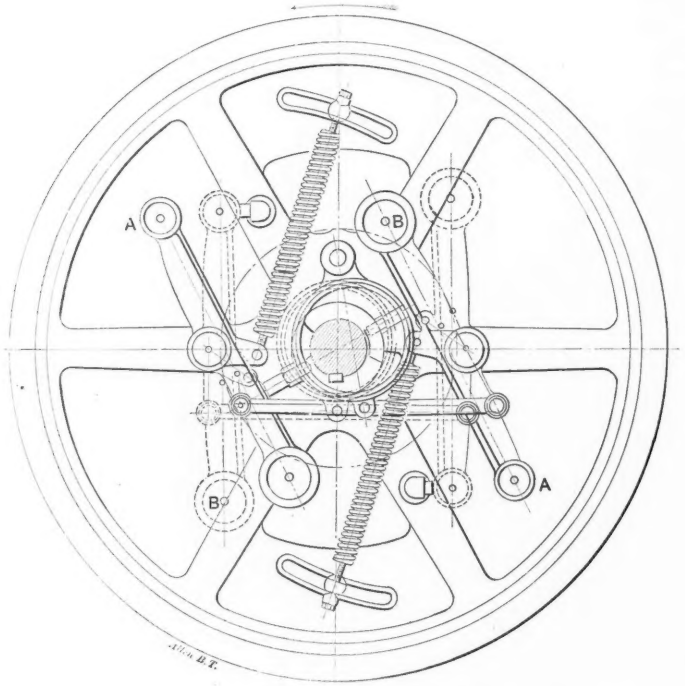


FIG. 5.—CENTRALLY BALANCED CENTRIFUGAL-INERTIA GOVERNOR.

The two steam valve brackets are constructed with a simple form of brace connection, forming a rigid truss, which avoids springing while in operation. These bell cranks receive their motion directly from the eccentric attached to the governor through the medium of a rocker arm running loose on a shaft which is rigidly attached to the main frame of the engine and supported by a bracket below. This combination of eccentric and bell-crank motion causes a rapid opening and closure of the steam ports, resulting in a remarkably quick cutoff for all points between zero and three-quarter stroke. The exhaust valves receive their motion from an independent eccentric on the engine shaft through the medium of a rocker arm, also running loose on the rocker shaft. This eccentric can be readily adjusted to cause the release and compression to occur at any point for best economy.

In Fig. 3 there is shown in plan and elevation a tandem-compound engine of this type. These views show the general design of cylinders, valves and reciprocating parts.

It will be noticed that three eccentrics are used, the one nearest the engine frame controlling the exhaust valves of both cylinders. The one in the middle controls the steam valves of the low-pressure cylinder and is a fixed eccentric, but so arranged that the cutoff in the low-pressure cylinder can be varied without changing the lead when the engine is not in motion. The other eccentric is attached to the

governor. This is not shown in this illustration. Through the medium of the rocker shaft and intermediate connections this eccentric changes the cutoff by varying the angle of advance and the travel of the valve.

The governor is so arranged on the shaft as to reduce the lead and initial pressure at light loads, and to this action is largely attributed the remarkable uniformity of steam consumption throughout varying ranges of load and cutoff.

An illustration is given in Fig. 4 of a tandem-compound, four-valve engine arranged for direct-connection to two generators. In design this type is characteristic of engines from 500 to 2,000 horse-power.

In Fig. 5 there is shown the automatic shaft governor used for all Fleming engines.

These engines have demonstrated very marked efficiency. Tests of single-cylinder engines as small as 135 horse-power, with cylinder fifteen inches in diameter and fifteen-inch stroke, show a steam consumption per indicated horse-power-hour of 23.4 pounds, with 120 pounds at the throttle non-condensing and a sixteen-inch by sixteen-inch made 1.2 pounds better than this under the same conditions. Compound engines with 150 pounds pressure give economies from eighteen to nineteen pounds non-condensing, while with favorable conditions the condensing engines realize between eleven and twelve pounds without superheat.

A recent test of a compound engine with high cylinder ratio and reheating receiver showed very high efficiency, particularly under varying load conditions. A uniform curve of steam consumption over a wide range of load was secured, as well as a close division of the load between the high and low-pressure cylinders. This was with the same point of cutoff in the low-pressure cylinder for all loads. The table below gives a schedule of the results of this particular test:

	Duration in Hours.	Per Minute.	Gauge Pressure Pounds at Throttle.	Vacuum by Gauge Inches.	Horse-Power. High-Pressure Cylinder.	Horse-Power. Low-Pressure Cylinder.	Horse-Power Total.	Steam Used per I. H. P. per Hour, Including Quantity Used in Reheater.
Test at about 1-6 load.	2	155.18	89.72	26.5	44.34	42.73	87.07	14.42
Test at about 5-8 load.	3	151.25	129.9	26.0	167.73	153.81	321.54	13.59
Test at about 7-10 load.	2	152.33	149.4	26.0	176.19	172.09	348.28	12.33
Test " full-rated ld.	5	150.09	152.0	25.9	249.96	251.59	501.55	12.66
Test at about 1 1-10 ld.	2	148.89	153.0	25.5	267.24	286.25	553.49	12.73

Some of these tests were made with comparatively low steam pressure. This might appear to have an influence in the production of the flat curve of steam consumption, but as the throttling action of the governor at the light load was so great as to reduce the initial pressure in the cylinder to about forty pounds, as compared with about ninety in the steam chest, it is evident that this is caused by a feature of the design rather than by any local condition. The company states in particular that this condition has been proven by other tests at uniform steam pressure, and that this flat steam consumption curve is characteristic of this engine. Recent tests of three tandem compound condensing engines of this type, working under 150 pounds and twenty-six inches to twenty-seven inches vacuum, have shown an efficiency of twelve and three-quarter pounds per indicated horse-power for engines of 275 horse-power capacity.

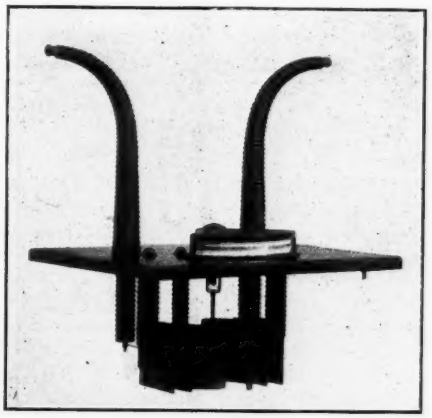
A number of tests have been made by Professor Carpenter and Professor Deitrichs, of Cornell University, and others by Professor Spangler, University of Pennsylvania, which corroborate the claims made for new records of efficiency.

Altogether there are now more than 200 of these engines in regular service, so that the experimental stage seems past.

Westinghouse Electrostatic Voltmeter.

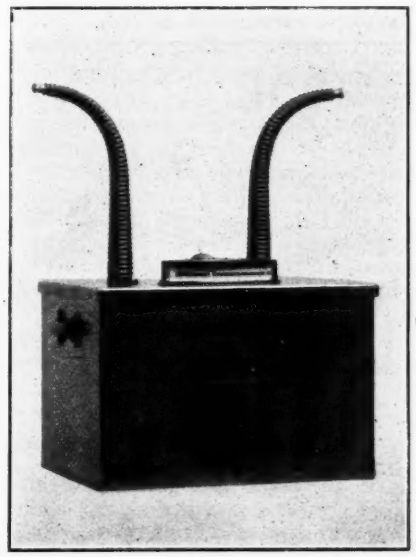
In electrical testing and experimental work high pressures are continually being used, and the measurement of these potentials is very often a perplexing problem. A number of different methods of high-pressure measurement have been used with varying degrees of success as to their accuracy, but all involve some uncertainty as to results. Where it is required that such apparatus as dynamos, transformers, cables, insulators, etc., be subjected to a specified pressure test as a condition of their acceptance, controversy often arises as to whether the required voltage has been applied.

The ideal and theoretically correct method of high-potential measurement is that employing an electrostatic voltmeter, but certain obstacles, the principal one of which was the lack of an insulating medium of sufficient dielectric strength, have heretofore prevented the development and application of this type of instrument. The Westinghouse Electric and Manufacturing Company has succeeded in overcoming these difficulties and in producing a meter that requires for its operation a negligible amount of energy, that is free from the effects of variation of wave-form, and is direct reading.



ELECTROSTATIC VOLTMETER, WITHOUT CASE.

The operating elements of this instrument are immersed in a special grade of oil contained in a metal-lined wooden case with an insulated cover. The metal lining acts as a screen to prevent outside fields or influences from affecting the meter. As the insulation is one of the most important parts of an instrument of this type, a few of the advantages derived from the use of oil may be summarized as follows:



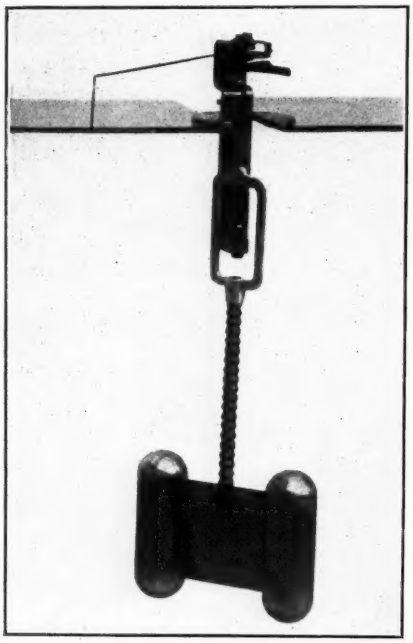
ELECTROSTATIC VOLTMETER, COVER REMOVED.

1. The distance between the operating elements may be greatly lessened, thereby reducing the size of the instrument.

2. The actuating forces are greatly in-

creased, due to the smaller distances between active parts and the high specific inductive capacity of the oil.

3. The reduction in distance between



MOVING ELEMENT, ELECTROSTATIC VOLTMETER.

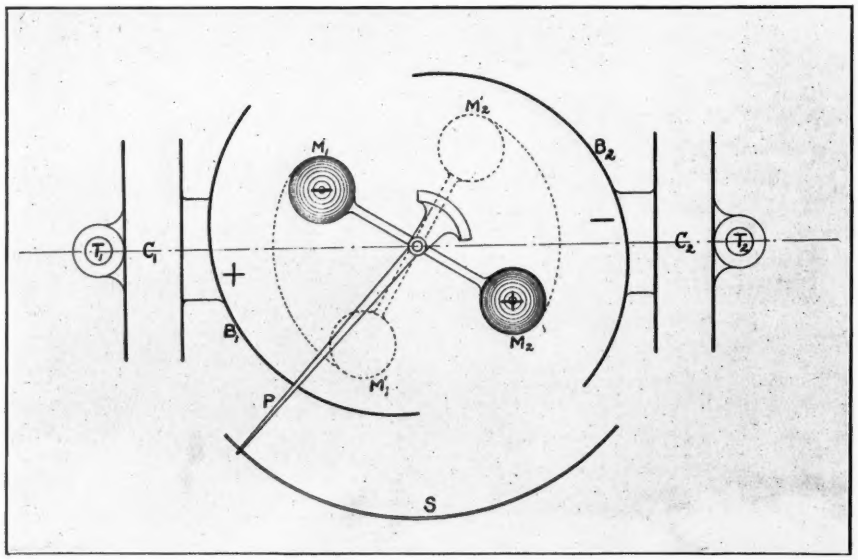
working parts of the meter makes possible a better form of scale.

4. The oil acts as a damper and makes the instrument nearly dead-beat and easy to read.

5. The oil buoys up the moving element, thus removing practically all weight from the bearings.

The arrangement and relative position of the parts of the meter are shown in the diagrammatic sketch. The curved plates B_1 and B_2 are of such a shape and so arranged with respect to the moving element that a deflection in a positive direction shortens the gap between it and the plates. The charges induced on the two extremities of the moving element are of such a nature that they exert forces of attraction on the charges on the plates, which bring about such a movement. The turning of the moving element is restricted by a spring and the deflection of the pointer is read on the scale. The condensers C_1 and C_2 are in series with other parts of the instrument, one plate of each being metallically connected to a curved plate, and the other to a terminal. The instrument may be operated with either or both condensers short-circuited, thus giving a wide range to the meter.

The curved plates, with the condenser-plates attached, are supported from the insulated cover by means of grooved posts of able insulating material. The separate condenser plates are supported in a similar manner. As all parts are firmly fastened to the same base they are held in constant relation to each other, and no error can result due to disarrangement of parts. The height of the oil in the case, together with the long paths over the suspension posts, prevents leakage between the plates. The horn-shaped terminals extend to the same distance below the oil as the suspension posts and are also grooved so as to prevent leakage over their surface.



DIAGRAMMATIC SKETCH OF WESTINGHOUSE ELECTROSTATIC VOLTMETER.

The bearing-springs and adjustments are similar to corresponding parts of Westinghouse standard indicating instruments. The cylindrical parts of the moving elements are hollow and so proportioned that the buoyant effect of the oil removes almost all weight from the bearings, thereby eliminating friction and wear. The scale over which the pointer passes is placed on an edgewise cylindrical form similar to the scale of an edgewise switchboard instrument, and the reading may be taken from a safe distance. With the exception of the glass window through which the scale is read, the cover over the pointer is all metal and acts as a screen to prevent external static fields from affecting the pointer. Instruments of this type may be obtained for potentials as high as 200,000 volts. The one shown in the illustrations may be used for voltages up to 100,000 volts with the condensers in circuit, or for approximately 50,000 or 25,000 volts with one or both condensers short-circuited. The case is twenty-two inches long, eighteen inches wide and fifteen and one-quarter inches high with terminals projecting eighteen inches above the case.

Opening of the Simplon Tunnel.

Consul Keene, of Geneva, reports that the opening of the Simplon tunnel, which was fixed for April 1, has been postponed to May, by action of the Swiss authorities. The consul says:

"The official opening of the new international line through the Simplon tunnel, after having been advertised for April 1, 1906, is now reported as being postpond until May 1. After having been for a considerable time under discussion, the mode of traction between Brigue and Domo d'Ossola—*i. e.*, on forty kilometres (about twenty-five miles)—is reported to be electrical, in accordance with a decision recently made by the Federal department of Swiss railroads.

"The Swiss system of traction now in use on the railroad Berthoud-Thoune, in the canton of Berne, will be applied with up-to-date improvements on the Simplon line. The first two electrical engines, when delivered at the end of the year, will first be tried on the Italian electrical lines of the Valtelline.

"Electrical traction on Swiss railroads is a new thing; but it seems only natural that Switzerland, so rich in 'white coal,' begins to utilize its wealth of water, and supersedes, by the power derived from it, the enormous quantity of coal imported from Germany, France, Belgium and England. This new trial of electrical power on such an important new line will be watched with keen interest. If successful, the new mode of traction will certainly be employed all over the country, and there may be openings for our manufacturers at home in that line."

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

MILLVILLE POWER DAM STARTED—The 25,000-horse-power dam across the Shenandoah river at Millville, Jefferson county, W. Va., for the Winchester & Washington Railway Company, has been practically completed.

CALIFORNIA POWER PROJECT—A project is under way to take up the development of the Feather river, in northern California, for the generation of some 400,000 horse-power, supplying the towns of Sacramento valley, Oakland, Alameda and Berkeley. This is the purpose of a $50,000,000 corporation which has been organized by Brown, Wilson & Company, of New York and San Francisco.

LONG ISLAND RAILROAD TO TAKE OVER TROLLEY SYSTEMS—Announcement has been made that the Long Island Railroad Company has formed a holding company to take over all of its trolley lines on Long Island. The company is known as the Long Island Consolidated Electrical Companies. A special meeting of stockholders of the Long Island Railroad has been called for March 14 next, to consider the guaranteeing of principal and interest on the bonds of the new company to an amount not to exceed $10,000,000.

THE ANIMAS POWER AND WATER COMPANY—Water was turned into two of the nine-foot turbines in the power plant of the Animas Power and Water Company, Durango, Col., on January 6. The company is now supplying customers in Silverton and as far as Ouray with electric power. The plant is located on the Animas river, about twelve miles from Durango. This is one of the largest electric generating plants in the West. At present it uses the waters of Cascade creek, which are conveyed through a flume six feet deep and eight feet wide to the main reservoir. The reservoir contains 250,000,000 cubic feet of water. The water is carried from the reservoir to a penstock 1,000 feet above the turbine. Each turbine generates 6,000 horse-power.

REBATING CASE AGAINST THE GENERAL ELECTRIC COMPANY—Federal agents of the Interstate Commerce Commission have been securing data, it is announced, on which charges of violation of the anti-rebate law will be made against the General Electric Company, Schenectady, N. Y. The case against the General Electric Company will hinge on the question whether a shipper of freight can legally receive a reduction from the published tariff of a railroad for switching and handling freight in his own yards. The General Electric Company has secured a reduction of rate because it handles its own freight in the yards, and the cars are delivered to the railroad companies ready to be made up into trains. The railroad companies have to do no switching.

TRACTION COMPANY EXTENSION—A special stockholders' meeting of the United Railways and Investment Company, which controls the traction lines in San Francisco, Cal., will be held in Jersey City, N. J., on January 31, to increase the common stock from $10,000,000 to $25,000,000. The greater part of the increase will be used to take over the Philadelphia company, which operates the traction lines in and around Pittsburg, Pa. Back dividends to the extent of $900,000 have accumulated on the preferred stock of the United Railways and Investment Company and a part of the proposed new stock issue will be used to pay these off. Mr. Arthur Holland, who resigned as president of the company some months ago, has been succeeded by Patrick Calhoun, of New York city.

NEW INDIANA TRACTION COMPANY—The Louisville & Northern Railway and Light Company, which was recently organized at New Albany, Ind., with a capital of $5,000,000 to construct a network of electric lines in southern Indiana, with an entrance into Louisville, Ky., over the line of the Louisville & Southern Indiana Traction Company, has filed a deed of trust to the American Trust and Savings Bank, of Chicago, to secure the payment of an issue of $2,500,000 twenty-year, five per cent bonds. The first series of $500,000 is to be disposed of at once to assist in paying the cost of construction and equipment of the initial twenty miles of electric line to be built by the company, and the remaining $2,000,000 is to be issued as needed. The deed covers all the property, property rights, franchises or privileges that the company may have or acquire in Floyd, Clark, Harrison, Washington, Orange, Jefferson, Scott, Jennings, Crawford, Perry, Spencer, Warrick, Vanderburg and Jackson counties in Indiana.

NEW CALIFORNIA RAILWAY—Articles of incorporation of the Sacramento & Lake Tahoe Railway Company have been filed. The directors are W. S. Graham, Leo Alexander, James H. Swift, Thomas H. Nicholls, Edward F. Haas, T. O. Sadleir, John A. Black, B. G. Raybould and Charles W. Reed. The object of the company is to construct and operate railway and telephone lines, ferry boats, wharves, docks and warehouses. The railway is to be part standard and part narrow gauge, operated by steam, electricity or other lawful motive power. The road will commence in the city of Sacramento Valley, and run in a northeasterly direction to a point near Folsom, thence to Placersville, thence in a northeasterly direction to the shore of the southerly portion of lake Tahoe. The estimated length of the road is 125 miles. It is stated that a branch road will be built from Folsom to Newcastle, thence to Auburn. The capital stock of the company is fixed at $7,500,000, of which $220,000 has been subscribed.

NEW PUBLICATIONS.

DEPARTMENT OF COMMERCE AND LABOR—The department of commerce and labor has issued the annual report of the lighthouse board. This gives the changes which have been made in the various districts, and much other useful information relating to the service.

ANNUAIRE POUR 1906, LE BUREAU DES LONGITUDES—The bureau of longitudes, Paris, France, has issued its annual for 1906. This annual contains a large amount of information of value to the astronomer and the civil engineer. A particular feature of this issue is an article by M. G. Bigourdan, giving instructions for taking observations during solar eclipses.

RECENT REPORTS ISSUED BY THE UNITED STATES NAVY DEPARTMENT—The United States navy department has recently issued the following reports: annual report of the chief of the bureau of steam engineering, annual report of the chief of the bureau of yards and docks, and a special notice to mariners, giving the regulations governing the use of the United States naval coastwise wireless telegraph systems. These stations, until further notice, will receive and transmit, without cost, commercial messages. The sender, however, is required to prepay all forwarding charges. The rules are also given for calling up stations. The call letters for the various stations are included, and the order of transmitting messages.

DANVILLE (VA.) LIGHT AND WATER DEPARTMENTS—The annual reports of the superintendent, secretary and treasurer of the water and light departments of Danville, Va., have been issued. These reports are for the year ending April 30, 1905. The report of the electric light department covers a period of sixteen months. During this time the new steam plant was completed at a cost of about $9,000. The plant consists of a 300-horse-power engine, suitable for compounding, so as to convert it into a 700-horse-power engine. This engine drives one 120-kilowatt, single-phase alternator for night use, and one 150-kilowatt, three-phase alternator for day use. During the past season it was found necessary to run both of these machines at night in order to carry the load, so that additional equipment will be needed for the present winter. The service now operates 162 arc lights, and supplies over 300 customers. The purchase of a new 150-kilowatt, three-phase alternator and 100 new enclosed arc lamps is recommended, and it is suggested that steps be taken to place all the wiring underground. The cost of operating the plant, including interest, is given as $14,229.

NEW INCORPORATIONS.

TOPEKA, KAN.—Alton Mutual Telephone Company. $4,000.

DAYTON, OHIO—Dayton Citizens' Electric Company. $100,000.

DOVER, DEL.—The Citizens' Gas and Electric Company. $800,000.

MONTELL, TEX.—Citizens' Telephone Company. Increased from $1,000 to $2,000.

RED OAK, IOWA—Red Oak Mutual Telephone Company. Increased to $15,000.

COLUMBUS, OHIO—Dean Electric Company, of Elyria. Increased from $300,000 to $1,000,000.

ELYRIA, OHIO—Elyria Southern Telephone and Toll Company. Increased from $40,000 to $75,000.

MONTGOMERY, ALA.—The Fayette Telephone Company. $2,000. Incorporators: W. J., V. M. and F. T. Johnson.

AUSTIN, TEX.—Montgomery Telephone Company, of Montgomery. $1,000. Incorporators: F. W. Peynghaus, M. S. Peynghaus and Robert J. Sullivan.

SOUTH McALESTER, I. T.—City Railway, of Chickasaw, I. T. $100,000. Incorporators: W. T. Cresley, M. B. Louthan, Scott Jones and W. T. Shannon.

PORTLAND, ME.—DeForest Great Lakes Wireless Company. $500,000. President, G. C. Ricker; treasurer, J. J. Hernan; clerk, M. W. Baldwin, all of Portland.

EASTON, MD.—The Easton & Cambridge Traction Company; $50,000. The Peninsular Traction Company; $200,000. The Bay Hundred Traction Company; $50,000.

AUSTIN, TEX.—Bartlett Electric Light and Motor Company. To do a lighting and heating business. $10,000. Incorporators: T. J. Record, E. W. Record, H. O. Jones.

JERSEY CITY, N. J.—The Reliance Telephone and Telegraph Company, Jersey City. $125,000. Incorporators: Arthur Johns, Lanier McKee, and Kenneth K. McLaren.

LOUISVILLE, KY.—The Okalona & Floyd Fork Telephone Company. $300. Incorporators: W. B. Thorne, South Park; R. W. Braithwait and G. W. Kirk, Shepherdsville.

GUTHRIE, OKLA.—The Dutton Telephone Company. $5,000. Directors: Edward Diehl, C. C. Fisher, Oliver Pruett and C. L. Frain, of Dutton, and E. G. Cornett, of Verden.

TRENTON, N. J.—The Eastern States Telephone and Telegraph Company, Jersey City. $1,000,000. Incorporators: Henry A. Bingham, Cornelius A. Cole and Alexander F. Garbe.

SPRINGFIELD, ILL.—Lakewood Mutual Telephone Company, Lakewood. To operate a telephone line. $2,500. Incorporators: Charles H. Duckett, J. E. Bowman, E. A. Weakley.

OTTAWA, QUEBEC—The Jamaica Light and Power Company. $250,000. To take over the business of the Jamaica Electric Light and Power Company, incorporated in Jamaica in 1889.

FALL RIVER, MASS.—International Electric Company, Fall River. $50,000. Incorporators: Alton E. Stevens, Rudolph F. Haffenreffer, Jr., Edward V. Fannin and Francis A. Duffey.

HARTFORD, CT.—Stanislaus Electric Power Company. $10,000,000. Incorporators: John C. Rice, of Boston, Mass.; Henry W. Palmer, of Boston, and Arthur Perkins, of Hartford.

LOUISVILLE, KY.—Springfield Home Telephone Company. $75,000. Incorporators: John McMurray, A. L. Dorsey, B. L. Moore, S. S. Moore, H. T. Stratton, Jr., and H. C. True.

ST. LOUIS, MO.—North St. Louis Power Company. $10,000, full paid. Incorporators: Robert Gaylord, Robert P. Young, C. R. Latham, S. T. G. Smith, John G. Keyser and M. C. Keyser.

MINNEAPOLIS, MINN.—The West Side Electric Power, Light and Heat Company. $50,000. To build a 3,000-horse-power plant to supply the needs of manufacturing plants of West St. Paul.

TROY, N. Y.—The Independent Telephone Company, of Fulton county. To operate telephone lines between Gloversville and Johnstown, Fonda, Fultonville and Amsterdam, and various other places in Fulton county. $5,000. Directors: Frederick M. Young, A. D. Kiblee and E. M. Brown, of Gloversville, and William T. Briggs and A. J. Baker, of Johnstown.

LINCOLN, NEB.—The Johnson County Home Telephone Company, of Tecumseh. $50,000. Incorporators: J. H. Luneman, W. D. Waganer, Otto Wettsetin, M. Bolton, John Barsby, F. E. Cobb, E. K. Cobb and G. W. Bearnes.

INDIANAPOLIS, IND.—The Indiana Rapid Transit Company. To build an electric railway from Terre Haute to South Bend, paralleling the Terre Haute & Logansport division of the Vandalia. $50,000. Directors: P. M. Dunn, A. M. Weeden, I. G. Helzer, J. P. Sommers, C. C. Cowgill, R. H. Meyers and Alva Dawson.

SAN FRANCISCO, CAL.—San Jose & Santa Clara Railroad Company. To construct a road from San Mateo through Redwood City, Menlo Park, Palo Alto, Mayfield, Mountain View, Santa Clara and San Jose, the terminal being at Alum Park. $5,000,000. Directors: Lewis E. Hanchett. John Martin, Harry Bostwick, Leo H. Lusman and Karl E. Kneiss.

INDIANAPOLIS, IND.—The Vanderburg & Posey Electrical Railway Company. $10,000. To build a road running between Evansville and New Harmony and Evansville and Mt. Vernon, connecting at some point with the Evansville & Princeton Traction Railway. Incorporators: C. F. Martin, E. B. Bixler, J. A. Higgins, Warner Wade and Frank Emerson.

SAN FRANCISCO, CAL.—The Parkside Transit Company. To promote an electric road five miles in length, which is to be constructed in the park district. $5,000,000. Directors: William H. Crocker, H. T. Scott, C. E. Green, J. J. Mahoney, Hugh Keenan, J. M. O'Brien, A. F. Morrison, W. Gregg, Jr., William Matson, W. B. Cope, Douglass S. Watson, J. E. Green.

SPRINGFIELD, ILL.—Harrisburg & Ohio River Railroad Company. To be constructed from a point on the Illinois Central Railway near Galatia, Saline county, Ill., to a point on the Ohio river, near Roseclare, Hardin county, Ill. $50,000. Incorporators and first board of directors: T. Edwin Bell, Hammond, Ind.; F. M. Pickett, O. W. Ferguson, J. J. Pickett, George Ledford and A. P. Harris, of Harrisburg, Ill.

SOUTH BEND, IND.—Kalamazoo, Elkhart & South Bend Traction Company. To construct an electric line between South Bend and Kalamazoo, passing through Mishawaka, Elkhart, Constantine and Three Rivers. $15,000. The officers are Adelbert Harris, president; John M. Caufield, vice-president; H. M. Morgan, second vice-president; Adam Hunsberger, treasurer; Edward C. Vincent, secretary; A. Bowman, auditor and assistant secretary.

PIERRE, S. D.—Marietta & Lake Railway Company, with nominal headquarters at Huron, S. D., and a branch at Caldwell, Ohio, where business will be transacted. The proposed line to be seventy miles long, to run from Marietta, Ohio, to Jewett, Ohio, through the counties of Washington, Monroe, Noble, Gurnsie and Harrison. $3,500,000. Incorporators: W. H. Young, A. McEdward Ball and Robert A. Davis, of Chicago, and Philip Lawrence and Marion Hoke, of Huron, S. D.

PORTLAND, ME.—Lewiston, Greene & Monmouth Telephone Company. To construct, operate, own and maintain telephone lines in the following cities and towns: Auburn, Lewiston, Turner, Lisbon, Webster, Wales, Greene, Leeds, East Livermore and Livermore in Androscoggin county; Buckfield and Hartford in Oxford county, and Litchfield, West Gardiner, Gardiner, Monmouth, Farmingdale, Hallowell, Augusta, Manchester, Vassalboro, China, Sidney, Waterville, Oakland, Belgrade, Vienna, Mount Vernon, Readfield, Wayne and Winthrop in Kennebec county, the general line to be from Lewiston through Greene, Wales, Leeds and Monmouth to Winthrop; from Lewiston to Auburn; from Greene to Turner, to Buckfield and to Hartford; from Monmouth through Litchfield and West Gardiner to Manchester; from Winthrop through Manchester, Augusta, Sidney, Vassalboro and Waterville to Oakland; from Monmouth to Wayne, and from Greene to Webster. $10,000. Officers: president, R. Alden, of Winthrop; treasurer, H. M. Blake, of Monmouth; directors, R. Alden, Eli Hodgkins, A. H. Bailey, H. M. Blake, J. H. Gilman and H. E. Foster.

ELECTRIC LIGHTING.

ALBANY, GA.—The Albany Power and Manufacturing Company is extending its line to East Albany.

DUNN, N. C.—Dunn is now lighted by means of the new electrical equipment recently installed in the plant owned and operated by the town.

PULASKI, TENN.—The Pulaski board of aldermen has closed a contract for a new plant to be three times as large as the one formerly in use.

TORRINGTON, CT.—The Torrington Electric Lighting Company is purchasing land for the extension of its plant as may be necessary in the future.

HADLEY, N. Y.—A power plant and storage reservoir will be built on the Sacandaga river, at Hadley, by the Hudson River Electric Power Company.

NEW ORLEANS, LA.—The city engineer's department has issued a building permit to the Consumers' Electric Company for a brick and steel power-house to cost $40,000.

BELTON, S. C.—The Belton Power Company is now furnishing power for running the cotton-mills at Belton and Williamston. The company is furnishing electric lights for the towns also.

ALBANY, ORE.—Negotiations between A. Welch, representative of Rhodes, Sinkler & Butcher, Philadelphia capitalists, and the Albany Electric Light and Water Company, have been completed, and the local plant transferred to the Philadelphia parties.

WILMINGTON, DEL.—The Wilmington Light, Heat and Power Company, which some time ago received a light franchise from the city, is engaged in preparing plans for a power-house. Operations on the building will be started some time early in the summer, and the plant will commence running as soon as possible.

PROSSER, WASH.—The county commissioners have granted a franchise to the Prosser Falls Land and Power Company to erect a power line along the county road to the western county boundary line for the purpose of transmitting electric power to Sunnyside for lighting that city, and also to furnish it power for its water system.

SAN FRANCISCO, CAL.—The merger of many of the lighting companies of the city and state of California has been accomplished by the payment into the Union Trust Company of the sum of $3,250,000. The California Gas and Electric Company is the absorbing company, and in the future the company will be called the Pacific Gas and Electric Company.

ALBANY, N. Y.—Certificates of merger of the Nassau Illuminating and Power Company, the Nassau County Gas Company and the South Shore Gas Company, of Freeport, with the Nassau & Suffolk Lighting Company have been filed with the secretary of state. The corporations operate in Nassau and Suffolk counties. The Nassau & Suffolk Lighting Company owns the entire capital stock of the merged concerns.

UTICA, N. Y.—Employés of the Utica Gas and Electric Company have completed the construction of the pole line between Utica and Rome, over which electricity will be conveyed to light the streets of Rome. Work of placing the poles was started the latter part of October. The current will come from the Trenton Falls plant of the Utica Gas and Electric Company. About 1,000 horsepower will be required.

MADERA, CAL.—The water that has been going to waste in Madera county for years at Crane valley, forty-eight miles from Madera, is about to be harnessed by the San Joaquin Power Company. A. G. Wishon, manager of the concern, at a special meeting for that purpose, has informed the board of trade that his company will be supplying electric power by February 15. Two large power-houses have been constructed at Crane valley, a substation is being built there, and several hundred miles of poles are being wired.

HOBART, N. Y.—Hobart village trustees have executed a contract with John P. Grant, of Stamford, for the lighting of their streets with electricity. The agreement is for five years and is to go into effect October 1, 1906, or sooner if the service is ready. There are to be thirty-six incandescent street lights of twenty-five candle-power and eleven smaller lights for the fire-department building. The village is to pay $500 per year for the service, and additional street lights are to be furnished if desired at $15 each per year.

PORTLAND, ORE.—The Cascade Power Company, which purposes to utilize the creeks and streams on Mount Hood for power purposes, has filed articles of incorporation in the county clerk's office. The plant will be located on Welch's farm, near the old toll gate, distant forty miles from Portland. The principal streams used will be Mill creek, Camp creek, Zigzag creek and Salmon river. The capital stock of the Cascade Power Company is $1,000,000. The incorporators are: E. R. Richardson, A. C. Churchill and William B. Chase and S. C. Spencer.

GADSDEN, ALA.—Articles of incorporation have been filed by the Coosa River Electric Power Company with a capital stock of $100,000. Officers have been elected as follows: president, Robert D. Johnston; vice-president, R. H. Cobb, of Anniston; secretary and treasurer, Henry K. White; general engineer and manager, Robert R. Zell, of Birmingham. The intention of the company is to build a dam and electric plant at Ten Island Shoals, at a point where the Seaboard Air Line crosses the Coosa river. This power is to be transmitted to Anniston, fourteen miles distant, to Gadsden and other points.

NIAGARA FALLS, N. Y.—The largest single contract for electric power ever made between a power-making plant and a factory concern has been consummated between the Niagara Falls Hydraulic Power and Manufacturing Company and the Pittsburg Reduction Company, of Niagara Falls. By the terms of the contract the power company must supply a block of 27,000 horse-power to the Pittsburg Reduction Company by January, 1907. The power is to be used for the operation of a new plant to be erected by the reduction company in the lower milling district. The building will be 600 feet long and will employ 400 men.

ALBANY, GA.—This city owns her waterworks and electric lighting systems, which are operated by a common commission and superintendent. No charge is made against the city on the books of this department for street lights, the lights in public buildings, fire hydrants, street sprinkling or the flushing of sanitary sewers. There are nearly a hundred fire hydrants, and an arc lamp at every street intersection in the city, as well as incandescent lamps in the alleys. The report of the superintendent of waterworks and electric lights shows that during the year just closing this department, after paying all expenses of maintenance and operation and for certain extraordinary improvements, turned into the city treasury net earnings of $7,194.60, or a trifle less than $600 a month.

SALT LAKE CITY, UTAH—John H. Wootton, of American Fork, has made application in the office of the state engineer for the appropriation of forty second-feet of water to be used for power purposes. The plant is to be erected in American Fork canyon and the electricity generated will be used for propelling machinery and lighting American Fork and the towns in that vicinity. A dam four feet in height is to be constructed at a point where the Deer creek issues into the main stream. The water will be carried 12,000 feet in a wooden flume three feet in diameter to where the plant is to be built. Two double wheels thirty-six inches in diameter are to be installed and operated under a head of 300 feet. The capacity of the plant will be 1,088 horse-power. The water will be diverted back into the main stream again after passing over the wheels.

VALLEJO, CAL.—District Attorney Raymond Benjamin, of Napa, has made an application to the board of supervisors of Napa county for a franchise for a lighting and power plant which will generate its power at Napa and supply all the towns and villages from Napa to Calistoga. The company has secured a franchise from the board of trustees of St. Helena for an electric power line and permission to lay gas mains through the streets of that town. The towns to be supplied will be Oakville, Yountville, Rutherford, St. Helena and Calistoga. The company is being organized by J. S. McDonald, of San Francisco, who recently built a new plant at Ukiah and has another electric lighting plant under construction at Rio Vista. His plans are said to have the backing of a number of San Francisco capitalists, whose aim it is to supply light and power to the smaller towns throughout the section which are now without electric lights.

ELECTRIC RAILWAYS.

LOWELL, MASS.—The Boston & Lowell Interurban Street Railroad has been granted its locations in Tewksbury.

PEKIN, ILL.—At a special meeting of the Morton village board the McKinley Interurban Syndicate was granted a franchise to run its line through that town.

ONEIDA, N. Y.—At a joint meeting of the common council and the board of public works a franchise allowing the Rome & Oneida Electric Railway Company to enter Oneida was granted.

BOONE, IOWA—Capitalists in Boone and Fort Dodge are backing a project to build an interurban railroad from Fort Dodge to Boone and one to Ames College. The money is pledged to build the line.

COLUMBIA CITY, IND.—The Winona Interurban Company has been granted a franchise to construct and operate an interurban railroad from Fort Wayne through Columbia city and Winona to Valparaiso.

WILLIAMSPORT, PA.—The Lycoming Improvement Company has authorized the issue of $300,000 collateral trust bonds, bearing five per cent interest. The money realized from the sale of these bonds will be used for improvements.

WATKINS, N. Y.—Dr. W. E. Colgrove, of Horseheads, has transferred the option he lately secured on the Elmira & Seneca Lake Railway to a New York banking firm, which represents the Elmira Water, Light and Railway Company.

WHEELING, W. VA.—A local improvement company, with a capital of a quarter of million dollars, has been formed and will acquire the Nichols farm. It is proposed to construct a trolley line to the property connecting with one of the city lines.

NORWICH, CT.—The municipal authorities have improved the plans which both the Norwich & Westerly Railway Company and the Norwich, Jewett City & Voluntown Street Railway Company have submitted with reference to the occupation of the streets of the city.

JACKSON, MICH.—The Jackson Consolidated Traction Company has been granted permission to put in a temporary grade crossing at the Lake Shore & Michigan Southern Railroad, so that the Francis street division may be extended to Vandercook lake resort. A subway costing $38,000, of which $20,000 is to be borne by the railroad, is to be started within a year.

AKRON, OHIO—The promoters of the Barberton, Wadsworth & Western Traction Company at a meeting of the Creston council were granted a franchise to construct and operate an electric line through the village. This road will extend, according to the statement of one of the promoters, from Barberton to Ashland, touching Wadsworth, Creston and a number of villages.

NAUGATUCK, CT.—The Naugatuck Valley Electric Railway Company, which is to build a trolley line from Naugatuck, south through the Naugatuck valley to Beacon Falls and thence to Seymour, has acquired the last piece of land which is needed as a right of way in Naugatuck. The work of clearing the land for the roadbed has begun and structural operations will now be pushed.

IOLA, KAN.—Iola has raised $25,000 for the Kansas Southern Electric Railroad, which is to be built between Iola and Humboldt. The subscription was required by St. Louis capitalists, who agree to furnish the rest of the money necessary to build the road to Humboldt. The road will be extended beyond Humboldt. An electric railroad has been in successful operation between Iola and Gas City and La Harpe for several years.

EDWARDSVILLE, ILL.—The St. Louis & Northeastern Railway, the third interurban electric line into Edwardsville, has been put in operation. The opening of the new division means the connecting by electricity of twenty-five or thirty Illinois cities and towns with St. Louis. It is now possible to travel entirely by electricity from St. Louis *via* Edwardsville to the following Illinois cities: Staunton, Mount Olive, Carlinville, Litchfield, Springfield, Champaign, Urbana, Decatur and Danville.

SPRINGFIELD, OHIO—Theodore Troupe, of Springfield, and George W. Baker, of Beaver, have purchased the Springfield-Chillicothe interurban line at receiver's sale, paying $66,000 for the property, which was appraised at $80,000. These men represent the reorganization committee, of which C. W. Christie, of Cleveland, is the head. The plan is to issue $800,000 worth of six per cent gold bonds, the creditors having agreed to take them in lieu of their claims.

PHILADELPHIA, PA.—At the annual meeting of the Lehigh Valley Transit Company held in Allentown, Pa., the following directors were elected: George H. Frazier, Edward B. Smith, Harry C. Trexler, W. F. Harrity, T. L. Johnson, Arthur E. Newbold, George O. Albright, Edward M. Young and David Young. The board of directors subsequently organized and elected the following officers: president, Harry C. Trexler; vice-president, Edward M. Young; secretary and treasurer, George H. Frazier.

CHATTANOOGA, TENN.—According to statements of S. W. Divine, the promoter of the Tennessee-Georgia Interurban Electric Railway, which is to be built from Chattanooga to Spring Place, Ga., the road is a certainty, and actual work of construction will begin in the near future. Mr. Divine expects to extend the road to Ducktown as soon as it is completed to Spring Place, Ga. The road will extend through the new army post reservation, the government authorities having given this privilege.

CAMDEN, N. J.—Work on straightening the line and cutting down the running time on the trolley road from Camden to New York has been begun under the direction of Stern & Silverman, acting in harmony with the Public Service Corporation. An air line is being built between Milltown and Elizabeth, N. J., which will save fourteen miles of riding and two and one-half hours in time between Trenton and New York. The new line will be twenty miles in length, and will be completed in time for summer travel.

FLORENCE, COL.—Thomas Robinson, president of the Florence Electric Street Railway Company, organized seven years ago, states that his company will be ready soon to commence construction of the first twenty-one miles of the line. The project is being financed by a New York syndicate. The road will do a passenger, express and freight business and will run from Florence to Canon City, the outlying coal camps and the Portland cement works. It will be built according to the most modern methods and will cost about $500,000.

WASHINGTON, PA.—It is stated that Washington and Pittsburg will be connected by trolley within eighteen months. Right-of-way men are at work for the line, which the Pittsburg Railways Company proposes to build from Mt. Lebanon to Canonsburg to connect with the interurban system of the Washington & Canonsburg will be connected by trolley within eighteen months. Right-between the east end, Canonsburg and Mount Lebanon, according to the surveys made, is twelve miles long. The contract for a line closing this gap is to be let this winter.

BRAZIL, IND.—Attorney David Morgan, secretary of the Indianapolis & Ohio Valley Traction Company, which was granted franchises in Brazil and county some months ago, says the company has the maps of the route completed and work on the line from Brazil to Bloomington will be begun in the spring and completed as early as possible. He is of the opinion that the line will be in operation between Brazil and Centre Point during the summer. It is also understood that in the spring a survey will be made north through Diamond to Rockville, and if the route proves satisfactory a line will be built. In case it is decided to build a line north the powerhouse will be built in Brazil.

DES MOINES, IOWA—An electric line from Des Moines through Newton and Boone to Fort Dodge, Gowrie, Lehigh, Rockwell City and several other points in the state is the promise of Homer Loring, of Boston, president of the Newton & Northwestern road. This is a road extending from Newton through Boone and Frazier to Rockwell City and crossing every trunk line in Iowa north of the Burlington. Mr. Loring states that this entire line will be electrified and will be operated in conjunction with the interurban from Des Moines through Colfax and Goddard to Fort Dodge and Rockwell City. It will be the longest electric line in the West. The line from Newton to Rockwell City is over ninety miles, while the branch from Frazier to Fort Dodge will be about twenty-seven miles long, and the line from Des Moines to Newton thirty-two miles.

PERSONAL MENTION.

MR. A. A. THRESHER, of Dayton, Ohio, is visiting in New York and will for a few weeks make his headquarters at the Waldorf-Astoria.

MR. R. ARMSTRONG has resigned as manager of the Christian County Telephone Company, Taylorville, Ill., and has been succeeded by W. B. Adams.

MR. W. B. GRAHAM has been appointed superintendent of the Paterson office of the Public Service Corporation of New Jersey. Mr. Graham takes the place of G. C. Dust, who leaves the Paterson office to accept a better position in the Newark office of the company.

MR. ROBERT J. COX has entered the independent telephone field as a purchasing and distributing agent, locating in Chicago, Ill. Mr. Cox was for fifteen years connected with the Western Electric Company. He will act as a general buyer for telephone, electrical and manufacturing companies.

MR. F. J. DIKES has been made manager of the Bell Telephone Company's Kansas City (Mo.) office, succeeding Albert Barrett, who becomes manager of district No. 1. This district includes the towns of Independence, Liberty, Harrisonville, Excelsior Springs, Fort Leavenworth, Paola, Olathe and Lawrence.

MR. IRVING MOULTROP, of the Edison Electric Illuminating Company, Boston, Mass., representing the steam turbine committee of the National Electric Light Association, has sailed for Europe to investigate turbines. It is the intention of the committee to report on the progress of the steam turbine here and abroad, and also to include in its work an investigation of gas turbines.

MR. E. W. RICE, technical director of the General Electric Company, Schenectady, N. Y., is mentioned prominently in connection with the forthcoming nominations for president of the American Institute of Electrical Engineers. Mr. Rice has had many years' experience in engineering work, holds a position of great responsibility and possesses a wide circle of friends in the electrical field.

MR. EDWARD E. CLEMENT, Washington, D. C., is well known to the electrical fraternity, not only as an engineer and attorney, but as a prolific writer on technical subjects. Mr. Clement's practice embraces three classes of business: general soliciting and patent work, expert patent work, and expert engineering work. Mr. Clement's engineering training was commenced at the United States Naval Academy at Annapolis, and continued under civil, mechanical and electrical engineers in New York and Washington. He served in the electrical division of the United States patent office from 1891 to 1898. He was president of a manufacturing company for two years and has been in practice continuously since 1898. He is an associate member of the American Institute of Electrical Engineers, a member of the executive committee of the District of Columbia branch of the Institute, and is also a member of the Franklin Institute and other bodies interested in electrical engineering. He has been a member of the bar since 1893 and is admitted to practice in all the courts of the United States.

MEMORIAL SERVICES.

MEMORIAL SERVICES were held at the New York Press Club on Sunday last, and among the deceased members whose names were honored was that of Mr. E. H. Mullin, formerly of the *Evening Sun*, and at the time of his death advertising manager of the General Electric Company.

OBITUARY NOTICE.

DR. WILLIAM RAINEY HARPER, president of the University of Chicago since its inception in 1891, died in Chicago on January 10. He was forty-nine years of age. Dr. Harper was born in New Concord, Ohio, in 1856. He graduated from Yale with the degree of Ph. D., at the age of nineteen. He was very prominently known early in his career as a teacher of Hebrew, and when he was twenty-four years of age he was called to the chair of Hebrew and cognate languages at the Baptist Theological Seminary at Morgan Park, Ill. He held this position for seven years until he was called to Yale in 1886 to become professor of Semitic languages. In 1889 he was chosen Woolsey instructor in Hebrew at the Yale Divinity School. The achievement for which Dr. Harper will be best remembered is the practical establishment by him of the University of Chicago.

ELECTRICAL SECURITIES.

Last week was a busy one in the stock market, the daily sales averaging more than 1,000,000 shares. The most important development was the renewed interest taken by the speculative public. It is stated in some quarters that the buying in this direction is now greater than at any time since last spring. The money situation improved considerably, the call rate being 8½ per cent, as against 60 per cent the previous week, and it is thought that the favorable bank statement, showing a large cash increase and gain in surplus reserves, will exert a further beneficial influence. Railroad earnings for December increased 20 per cent, as against a year ago, and the prosperity in the iron and steel trade continues unabated. The government reports domestic exports for the calendar year 1905 to the amount of $828,107,062, a gain of $98,517,911, and the figures for domestic exports of agricultural products made a good showing.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JANUARY 13.

New York:	*Closing.*
Brooklyn Rapid Transit	91½
Consolidated Gas	170¾
General Electric	179
Interborough Rapid Transit	233
Kings County Electric	200
Manhattan Elevated	160½
Metropolitan Street Railway	125½
New York & New Jersey Telephone	156½
Westinghouse Manufacturing Company	190

The earnings of the Brooklyn Rapid Transit system are breaking all records. In December the gross increased $177,000 and during the first seven days of January the gross increase averaged $7,300 per day.

The General Electric Company reports its consolidated profit and loss account for the nine months from January 31 to October 31 as follows: sales, $29,346,567; royalties and sundry profits, $16,193; interest, dividends and discounts, $726,914; total income, $30,089,674; cost of manufacture and selling, $24,129,218; interest on debenture, $56,503; dividends paid, $2,895,610; total deductions, $27,081,331; surplus, $3,008,343; previous surplus, $9,569,196; total surplus, $12,577,539.

Boston:	*Closing.*
American Telephone and Telegraph	137½
Edison Electric Illuminating	245
Massachusetts Electric	68
New England Telephone	135½
Western Telephone and Telegraph preferred	95

The Edison company, of Boston, has declared a regular quarterly dividend of 2½ per cent, payable February 1, to stockholders of record at close of business January 16.

Philadelphia:	*Closing.*
Electric Company of America	12
Electric Storage Battery common	83
Electric Storage Battery preferred	83
Philadelphia Electric	8
Philadelphia Rapid Transit	32
United Gas Improvement	93¼

The Electric Company of America directors have declared the regular semi-annual dividend of 35 cents per share, a rate of 7 per cent per annum. The dividend is payable January 31 to stock of record January 20. Books close January 20, reopen February 20.

Chicago:	*Closing.*
Chicago Telephone	138½
Chicago Edison Light	161
Metropolitan Elevated preferred	72⅛
National Carbon common	80
National Carbon preferred	116
Union Traction common	12
Union Traction preferred	40

Directors of the Chicago Edison company have declared the regular 2 per cent quarterly dividend, payable February 1. Books close January 20 and reopen February 1.

INDUSTRIAL ITEMS.

THE SPRAGUE ELECTRIC COMPANY, New York city, in bulletin No. 224 illustrates and describes type D direct-current motors.

THE H. T. PAISTE COMPANY, Philadelphia, Pa., has ready for distribution bulletin No. 28 descriptive of fusible hanger boards, Paiste panelettes and Paiste taplets. These are well illustrated in the bulletin.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., is distributing a series of blotters made up in several unique designs, advertising the Westinghouse fan motors. The calendar months included are those of June, July, August and September.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has ready for distribution its January monthly. This contains a number of sketches concerning the Emerson products and calls particular attention to the Emerson fans for 1906. The Emerson catalogue for 1906 fans is now ready for distribution.

THE INDIA RUBBER AND GUTTA PERCHA INSULATING COMPANY, Yonkers, N. Y., is distributing a unique set of "Indian Girl" calendars to electrical dealers and users of wires and cables as an advertisement for "Habirshaw" wires and cables. This calendar set is decidedly attractive, and is suitable for a lady's writing table.

THE LIMA INSULATOR COMPANY, Lima, N. Y., in catalogue No. 1 describes and illustrates its line of high-grade porcelain insulators made from Lima porcelain. This material is used for power transmission, street railway, electric light, telephone and telegraph work. The company's sales office is at 280 Devonshire street, Boston, Mass.

THE BRILLIANT ELECTRIC COMPANY, Cleveland, Ohio, has appointed the E. B. Latham Company, 39 Vesey street and No. 4 Murray street, New York city, general sales agent in Greater New York for both the "Brilliant" tipless and tip lamps. An agency has also been established at Providence, R. I., with the Union Hardware and Electric Supply Company.

THE GENERAL STORAGE BATTERY COMPANY, New York city, announces that on account of the great increase in the demand for the "Bijur" high-duty elements it has decided to enlarge its factory at Boonton, N. J., by erecting buildings furnishing an additional 48,000 square feet of floor space, and to install hydraulic and steam or gas generating machinery aggregating over 1,000 horse-power.

THE CHICAGO PNEUMATIC TOOL COMPANY, Chicago, Ill., announces that on account of the great increase in its compressor business arrangements are under way for increasing the capacity of its works at Franklin, Pa., to give an annual output of between 650 and 700 machines. During 1905 the Chicago Pneumatic Tool Company was able to turn out only 400 compressors because of its limited facilities and therefore could not keep pace with its orders.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has supplied the pumping equipment for an irrigation system furnished to the Makee Sugar Company, Keila, island of Kauan, Hawaiian territory. The primary driver consists of a specially designed impulse water-wheel operating under a fall of 400 feet of water. This water-wheel drives a Bullock alternating-current generator rated at 300 kilowatts, three-phase, sixty cycles. The current will be utilized by induction-motors driving pumping machines.

THE EWING-MERKLE ELECTRIC COMPANY, St. Louis, Mo., has ready for distribution catalogue No. 58 descriptive of special fixtures and wiring supplies. This catalogue is very complete and lists apparently every variety of electric light fixture and appliance. In addition to the metal fixtures there is a large line of glass shades displayed and many forms of patented reflectors. A very complete index makes reference easy, and in addition to the list index there are a telegraph code and code-word index, a plate index and a price-list index.

THE BISHOP GUTTA PERCHA COMPANY, New York city, held a meeting of the stockholders at the office of the company, 420 East Twenty-fifth street, on January 10. The following were elected directors: Henry A. Reed, William Boardman Reed, Henry D. Reed, Louis F. Reed and Ellon I. Anderson. Henry A. Reed was elected president and treasurer and William Boardman Reed vice-president. Louis F. Reed was appointed secretary and Henry D. Reed superintendent. The usual semi-annual dividend of five per cent was declared.

M. W. DUNTON & COMPANY, Providence, R. I., issues a neat and attractive sample card of its regular stock of tapes and sleevings for armature winding. A set of these will be mailed to any one engaged in this branch of the electrical business. A large stock of this material is carried at all times and the company is ready to make prompt shipments. Having had repeated calls for insulating paper from regular customers, the company has made arrangements to supply this by carrying a large stock of "Red Rope" paper, made with especial attention to its insulating qualities.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., is distributing a series of calendar blotters and a handsome catalogue descriptive of varnished cambric cables. In addition to this there is bulletin No. 4431, dealing with illuminating engineering applied to interior lighting. There is also supply catalogue No. 7594 listing parts of edgewise-wound, parallel-rod, 220-volt, direct-current, power-circuit enclosed arc lamps, forms 5 and 4, without cutout or cutout resistance. Flier No. 2169 describes and illustrates double push-button flush pocket switches, and flier No. 2170 describes "Competition" knife switches.

THE GREEN FUEL ECONOMIZER COMPANY, Matteawan, N. Y., has made a number of important sales of fan apparatus for heating and ventilating. The company, which has long been famous as the builder of the Green fuel economizer, began the manufacture of fans, blowers and exhausters upon a large scale some time ago. Among the orders recently closed are the following: two 310-inch induced draught fans for the American District Steam-Heating Company, Minneapolis, Minn.; a 280-inch heating and ventilating fan and heater for Kimberly & Clark, Kimberly, Wis.; a volume blower for the Chandler Planer Company, Fitchburg, Mass.; a planing mill exhauster for the Whiton Machinery Company, Whitonville, Mass.; an economizer, induced draught fan and engine for the Massachusetts Chemical Company, Walpole, Mass.; a mine-ventilating outfit for the Minonk Coal Company, Chicago, Ill., and two complete induced draught fans, engines and economizers for the Traders' Paper Board Company, Bogota, N. J.

TELEPHONE AND TELEGRAPH.

WEST REDDING, CT.—The American Telephone Company is erecting a telephone station.

MINNEAPOLIS, MINN.—The Northwestern Telephone Company has reported to the state auditor gross earnings in Minnesota for the year ending November 30, of $1,032,492.56.

DECATUR, ALA.—The Morgan County Telephone Company, an independent concern, is pushing work on its long-distance lines to Mobile, Nashville and Memphis, and within the next few months will be giving long-distance service to all points east of the Mississippi.

ANGELICA, N. Y.—At a meeting of the board of trustees of the village of Angelica a franchise was granted to Frank Sullivan Smith as receiver of the Pittsburg, Shawmut & Northern Railroad Company, giving that company the right to build and operate a telephone system in the village.

YORK, PA.—At the annual meeting of the stockholders of the York Telephone Company the following officers were elected: president, the Hon. D. F. Lafean; vice-president, John McCoy; secretary, H. H. Weber; treasurer, C. C. Frick; general manager, George B. Rudy; attorney, George S. Schmidt; finance committee, the Hon. D. F. Lafean, John McCoy and H. H. Weber.

FRANKFORT, N. Y.—At the annual meeting of the Frankfort, East & West Schuyler Mutual Telephone Company the following officers were elected for the ensuing year: president, Aaron Eaton; vice-president, Elmer Ladd; secretary and treasurer, L. H. Robinson. The company by a unanimous vote decided to establish an independent exchange, in which it is thought other county lines will unite.